



# Battery Data MI Importer Template

## Quick Start Guide

*Laurie H. Levinson*  
*Glenn Research Center, Cleveland, Ohio*

## NASA STI Program . . . in Profile

Since its founding, NASA has been dedicated to the advancement of aeronautics and space science. The NASA Scientific and Technical Information (STI) Program plays a key part in helping NASA maintain this important role.

The NASA STI Program operates under the auspices of the Agency Chief Information Officer. It collects, organizes, provides for archiving, and disseminates NASA's STI. The NASA STI Program provides access to the NASA Technical Report Server—Registered (NTRS Reg) and NASA Technical Report Server—Public (NTRS) thus providing one of the largest collections of aeronautical and space science STI in the world. Results are published in both non-NASA channels and by NASA in the NASA STI Report Series, which includes the following report types:

- **TECHNICAL PUBLICATION.** Reports of completed research or a major significant phase of research that present the results of NASA programs and include extensive data or theoretical analysis. Includes compilations of significant scientific and technical data and information deemed to be of continuing reference value. NASA counter-part of peer-reviewed formal professional papers, but has less stringent limitations on manuscript length and extent of graphic presentations.
- **TECHNICAL MEMORANDUM.** Scientific and technical findings that are preliminary or of specialized interest, e.g., "quick-release" reports, working papers, and bibliographies that contain minimal annotation. Does not contain extensive analysis.
- **CONTRACTOR REPORT.** Scientific and technical findings by NASA-sponsored contractors and grantees.
- **CONFERENCE PUBLICATION.** Collected papers from scientific and technical conferences, symposia, seminars, or other meetings sponsored or co-sponsored by NASA.
- **SPECIAL PUBLICATION.** Scientific, technical, or historical information from NASA programs, projects, and missions, often concerned with subjects having substantial public interest.
- **TECHNICAL TRANSLATION.** English-language translations of foreign scientific and technical material pertinent to NASA's mission.

For more information about the NASA STI program, see the following:

- Access the NASA STI program home page at <http://www.sti.nasa.gov>
- E-mail your question to [help@sti.nasa.gov](mailto:help@sti.nasa.gov)
- Fax your question to the NASA STI Information Desk at 757-864-6500
- Telephone the NASA STI Information Desk at 757-864-9658
- Write to:  
NASA STI Program  
Mail Stop 148  
NASA Langley Research Center  
Hampton, VA 23681-2199



# Battery Data MI Importer Template

## Quick Start Guide

*Laurie H. Levinson*  
*Glenn Research Center, Cleveland, Ohio*

National Aeronautics and  
Space Administration

Glenn Research Center  
Cleveland, Ohio 44135

Trade names and trademarks are used in this report for identification only. Their usage does not constitute an official endorsement, either expressed or implied, by the National Aeronautics and Space Administration.

This work was sponsored by the  
Transformative Aeronautics Concepts Program.

*Level of Review:* This material has been technically reviewed by technical management.

Available from

NASA STI Program  
Mail Stop 148  
NASA Langley Research Center  
Hampton, VA 23681-2199

National Technical Information Service  
5285 Port Royal Road  
Springfield, VA 22161  
703-605-6000

This report is available in electronic form at <http://www.sti.nasa.gov/> and <http://ntrs.nasa.gov/>

## Table of Contents

<b>Overview .....</b>	<b>1</b>
<b>Required Setup for Use of M-SHELLS Importer Template Workbook .....</b>	<b>2</b>
<b>Processing of M-SHELLS Raw Data Files .....</b>	<b>3</b>
<b>Message Dialogs .....</b>	<b>4</b>
(A) <i>Incomplete Processing Warning Message .....</i>	5
(B) <i>File Name Conflict Warning Message .....</i>	5
(C) <i>Renaming Open Workbook Informational Message .....</i>	6
(D) <i>Output Path Too Long Warning Message .....</i>	7
(E) <i>Data Import Error / Input File Path Too Long Error Message .....</i>	7
<b>Input File Specifications .....</b>	<b>8</b>
(A) <i>Summary (Specimen) Data File .....</i>	8
(B) <i>Raw Test Data File .....</i>	9
<b>Output File Specifications .....</b>	<b>9</b>
<b>Uploading Data to the MI Database .....</b>	<b>11</b>
<b>Viewing Uploaded Data.....</b>	<b>11</b>
<b>Appendix A - Summary Data File Worksheet Layout.....</b>	<b>19</b>
<b>Appendix B - Raw Test Data File Worksheet Layouts .....</b>	<b>21</b>
<b>Appendix C – Template-Based File “Test Information” Worksheet Specifications.....</b>	<b>29</b>

## List of Figures

<b>Figure 1. BatteryDataImporter.xlsx Importer Template Graphical User Interface .....</b>	<b>1</b>
<b>Figure 2. Excel Options Dialog, Trust Center Selection.....</b>	<b>2</b>
<b>Figure 3. Excel Trust Center Dialog, Trusted Locations Selection .....</b>	<b>3</b>
<b>Figure 4. Microsoft Office Trusted Location Folder Selection Dialog .....</b>	<b>3</b>
<b>Figure 5. M-SHELLS User Interface Display Following Data Import Processing.....</b>	<b>4</b>
<b>Figure 6. Error Exit Warning Message.....</b>	<b>5</b>
<b>Figure 7. File Name Conflict Dialog .....</b>	<b>6</b>
<b>Figure 8. “Renaming Open Workbook” Message .....</b>	<b>6</b>
<b>Figure 9. “Output Path Too Long” Warning Message .....</b>	<b>7</b>
<b>Figure 10(a). Error Message Displayed when Unable to Access Summary Data File .....</b>	<b>8</b>
<b>Figure 10(b). Error Message Displayed when Unable to Access Raw Test Data File.....</b>	<b>8</b>
<b>Figure 11. Test Data: Battery Performance Table Record Hierarchy .....</b>	<b>10</b>
<b>Figure 12. MI: Toolbox Login Screen .....</b>	<b>11</b>
<b>Figure 13. Database Selection within MI: Toolbox .....</b>	<b>11</b>
<b>Figure 14. MI: Toolbox Excel Importer Selection Process .....</b>	<b>12</b>
<b>Figure 15. MI: Toolbox Excel Importer GUI.....</b>	<b>12</b>
<b>Figure 16. File Selection and Data Upload Initiation via MI: Toolbox Excel Importer.....</b>	<b>13</b>
<b>Figure C-1. “Test Information” Worksheet Format for Template-based Files (Pt 1 of 2) ...</b>	<b>30</b>
<b>Figure C-2. “Test Information” Worksheet Format for Template-based Files (Pt 2 of 2) ...</b>	<b>31</b>

## List of Tables

<b>Table 1. Mapping of Database Attributes to Excel Template-Based Source File Data .....</b>	<b>13</b>
<b>Table A-1. Summary Data File Pedigree Worksheet Input Data Format Specification .....</b>	<b>20</b>
<b>Table B-1. Input Data Format Specification for Test Data Imported to Template-Based File's "Global_Info_Data" Worksheet .....</b>	<b>22</b>
<b>Table B-2. Input File Column Order Specification for Test Data Imported Directly to Template-Based File's "Channel_Data" Worksheet.....</b>	<b>23</b>
<b>Table B-3. Specifications for Calculated Values Output to Template Based File's "Channel_Data" Worksheet and Optionally Included in Raw Test Data Input File .....</b>	<b>24</b>
<b>Table B-4. Column Order Specification for Data Displayed on Template-Based File's "Channel_Data" Worksheet (Calculated Values Highlighted in Yellow).....</b>	<b>25</b>
<b>Table B-5. Input File Column Order Specification for Test Data Imported Directly to Template-Based File's "Statistics_Data" Worksheet .....</b>	<b>26</b>
<b>Table B-6. Specifications for Calculated Values Output to Template-Based File's "Statistics_Data" Worksheet and Optionally Included in Raw Test Data Input File .....</b>	<b>27</b>
<b>Table B-7. Column Order Specification for Data Displayed on Template-Based File's "Statistics_Data" Worksheet (Calculated Values Highlighted in Yellow).....</b>	<b>28</b>
<b>Table C-1. Source Data Specifications for Data Displayed on Template-Based File's "Test Information" Worksheet, Part 1 of 2.....</b>	<b>32</b>
<b>Table C-2. Source Data Specifications for Data Displayed on Template-Based File's "Test Information" Worksheet, Part 2 of 2.....</b>	<b>33</b>



## Overview

The importer template and automation software described in this document have been developed in order to automate the process of uploading M-SHELLS raw test data and associated specimen information to the **Test Data: Battery Performance** table of the Materials Intelligence (MI) database. The automation software graphical user interface (GUI) and associated importer template are contained in the “**BatteryDataImporter.xlsx**” Excel workbook (see Figure 1), and may be used to import M-SHELLS summary, or pedigree, data and the associated raw test data results into an importer template-based file, formatted in such a way as to be ready for immediate upload to the database. The provided GUI enables the user to select one or more desired “summary data files” via a file browser dialog, with each file containing one or more cell IDs, as well as the corresponding test cell pedigree information, for the associated raw test data file(s) to be processed. Based upon the cell ID(s) included in each selected summary data file, the workbook(s) containing the detailed raw test data results will then be identified and processed in an automated fashion. For this process to work as intended, all files containing the detailed raw test data results are expected to have file names of the form, “**CAS\_Cell[Cell\_ID]\*.xls†**”, where **[Cell\_ID]** is the “**Cell #**” value read from the summary data file, and **\*** and **†** may each be blank, or be any text string consistent with valid Microsoft Windows file naming rules. The **\*** text string, if provided, will be interpreted by the automation software as a description of the type of test performed, and should begin with the “**\_**” (underscore) character, with individual words separated either by spaces or the “**\_**” character. Note that all files to be processed at one time, i.e., all summary data files selected by the user via the file browser dialog and all associated raw test data files containing the detailed test results for the referenced cell IDs, **must** be in the same directory as one another. In addition, **for the importer template automation software to operate properly, the importer template and GUI file, “BatteryDataImporter.xlsx,” must not be renamed outside of Excel.**

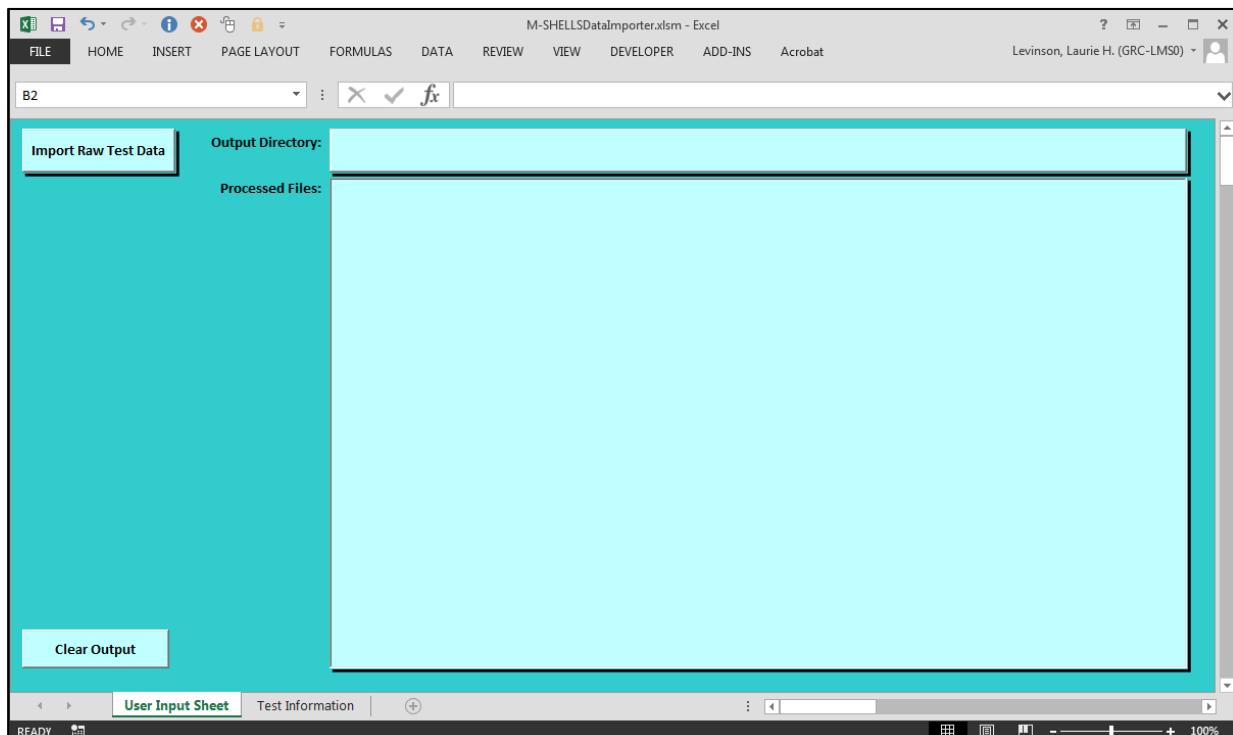


Figure 1. BatteryDataImporter.xlsx Importer Template Graphical User Interface

## **Required Setup for Use of M-SHELLS Importer Template Workbook**

1. To begin, place the "**BatteryDataImporter.xlsxm**" template workbook in the desired directory on the user's machine
2. Configure Excel to add the required Trusted Locations, to enable the M-SHELLS Data Importer template, and any resulting processed data files that might subsequently be created using the template, to function properly:
  - a. Open Excel
  - b. Select **File** → **Options** → **Trust Center** (See Figure 2 (a), below)
  - c. Click on the **Trust Center Settings** CommandButton, on the right (Figure 2 (b))
  - d. Select **Trusted Locations** from the list on the left (Figure 3 (a))
  - e. Click on the **Add new location...** CommandButton on the bottom right (Figure 3 (b)) to open the **Microsoft Office Trusted Location** dialog (Figure 4)
  - f. Click on the dialog's **Browse...** CommandButton, browse to the directory where the "**BatteryDataImporter.xlsxm**" workbook is located, and select the relevant directory
  - g. If M-SHELLS data files to be processed are to be located in the selected folder, or in a sub-folder of the selected folder (i.e., if files to be processed will be placed within the same directory hierarchy as the template workbook), ensure that the **Subfolders of this location are also trusted** CheckBox is checked (See Figure 4)
  - h. Click on the **Microsoft Office Trusted Location** dialog's **OK** CommandButton to accept the updated settings and close the dialog
  - i. If data files to be processed using the "**BatteryDataImporter.xlsxm**" workbook are to be located in a directory hierarchy other than the directory where the template file is located, or if at any point, M-SHELLS raw data files to be processed are placed within a directory hierarchy other than one which has already been added as a trusted location, repeat the above process to add that directory as a trusted location, ensuring that the **Subfolders of this location are also trusted** CheckBox is also checked for any added directory

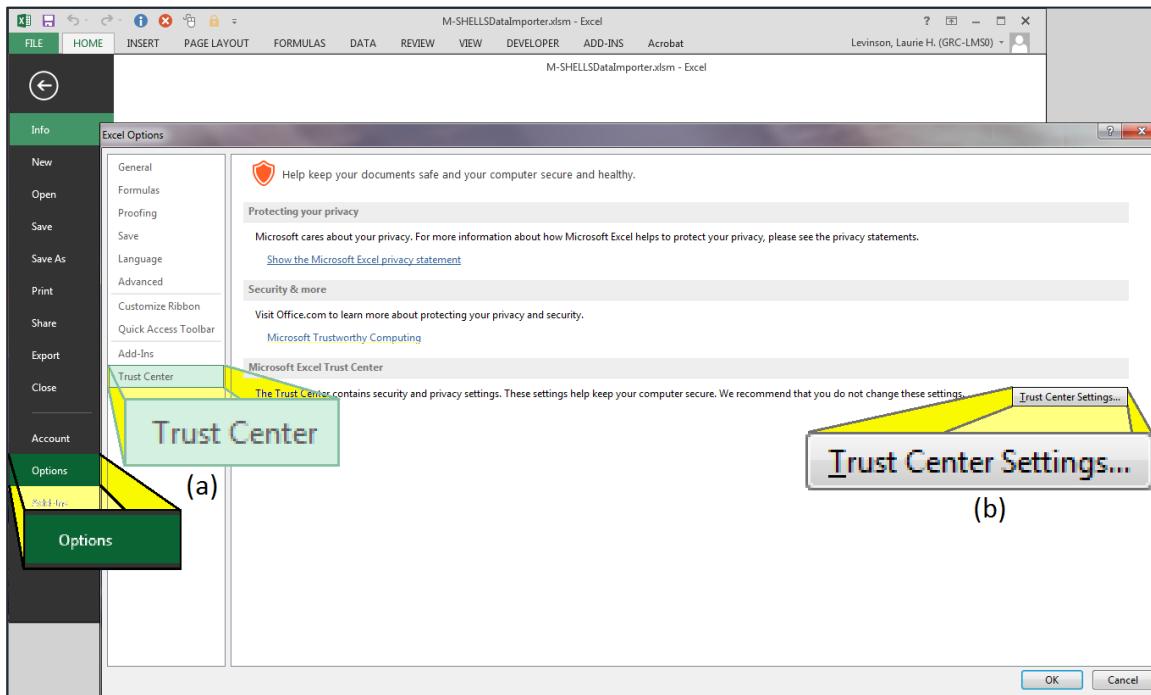


Figure 2. Excel Options Dialog, Trust Center Selection

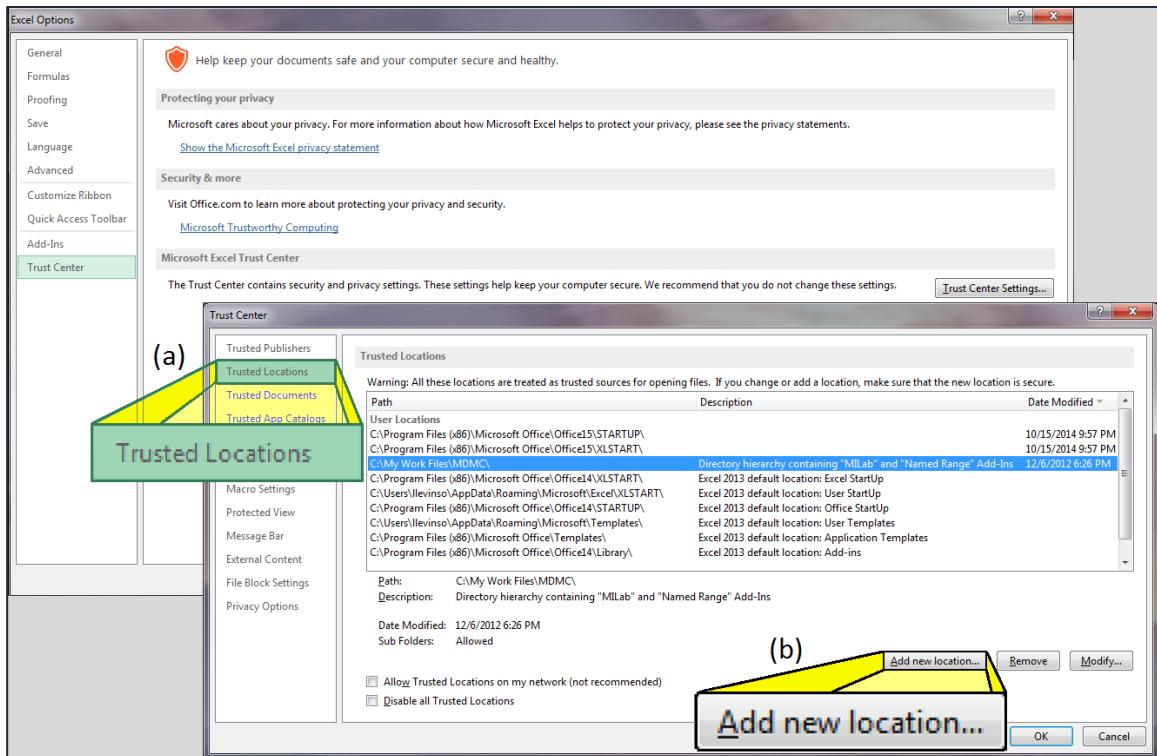


Figure 3. Excel Trust Center Dialog, Trusted Locations Selection

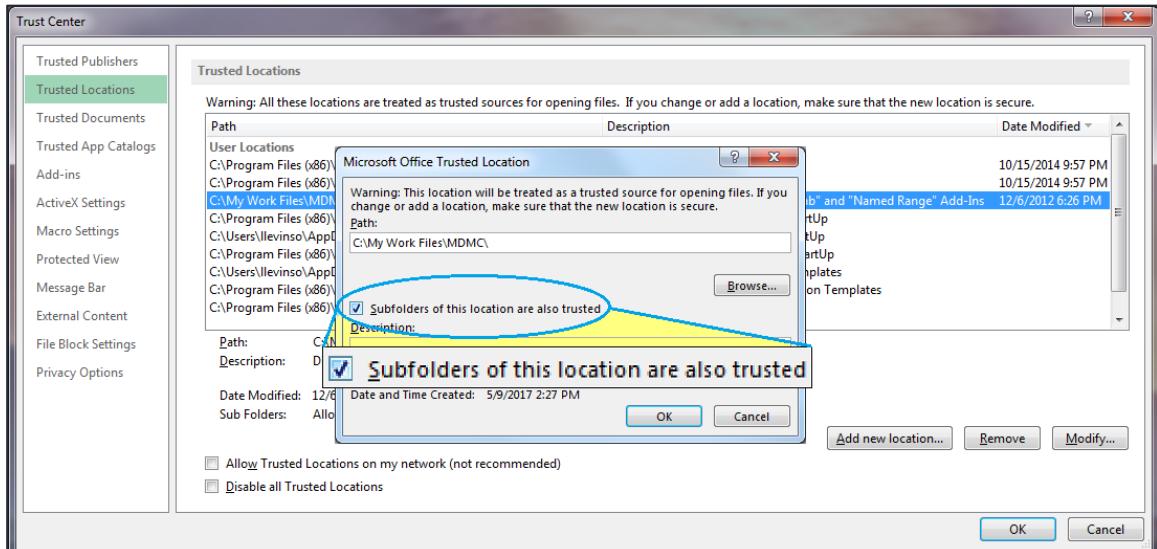


Figure 4. Microsoft Office Trusted Location Folder Selection Dialog

## Processing of M-SHELLS Raw Data Files

1. To begin processing M-SHELLS data, it is first necessary to ensure that any raw test data files and their corresponding test data summary file(s) are located in the same folder as one another
2. Next, open the "**BatteryDataImporter.xlsxm**" importer template workbook
3. Click on the **Import Raw Test Data** CommandButton on the "**User Input Sheet**" worksheet, and browse to the directory where the raw test data and summary data files are located
4. Select the summary data file(s) – and **only** the summary data files – containing pedigree information for the raw test data files to be processed, and then click on the **Open** CommandButton

5. The user interface will then update as files are processed, with the output directory where the template-based processed data files are being placed, and the file name for each processed data file, displayed in the corresponding TextBoxes on the “**User Input Sheet**” worksheet. Output files will be placed, by default, in a subdirectory of the directory where the raw data files are located, using a directory name of the form, “**DBData\_[mm-dd-yyyy]**”, where the date represents the current date at the time of processing. If the indicated directory does not already exist, it will be created. Output files will be given a file name of the form, “**MI\_[source\_file\_name]\_[mm-dd-yyyy]\_[hh\_mm\_ss].xlsm**”, with the date and time taken from the “**Start Date/Time**” field on the template-based file’s “**Global\_Info\_Data**” worksheet or, if that field is empty, the original raw test data file timestamp.
6. When all selected files have been processed, a message dialog is displayed with the message, “**Processing complete... [x] files created**,” with **x** = the number of processed data files successfully created (see Figure 5)
7. Click on the **OK** CommandButton to close the message dialog
8. To open the folder where the processed data files have been placed, double-click on the folder name displayed in the “**Output Directory**” TextBox at the top of the “**User Input Sheet**” worksheet
9. To view a processed data file, double-click the relevant filename listed in the “**Processed Files**” TextBox. Note that, in order to prevent Excel from prompting a user each time prior to closing a template-based file to ask whether to save changes, even when no changes were made by the user, the corresponding prompt has been disabled for template-based files. Thus, when closing a processed data file, if the user has, in fact, made changes that are to be saved, no message will be displayed prior to closing the file, to warn the user that there are unsaved changes.
10. To process additional raw test data files, click on the **Clear Output** CommandButton on the “**User Input Sheet**” worksheet to clear the user interface display, and then repeat the listed process, beginning with item (3) above

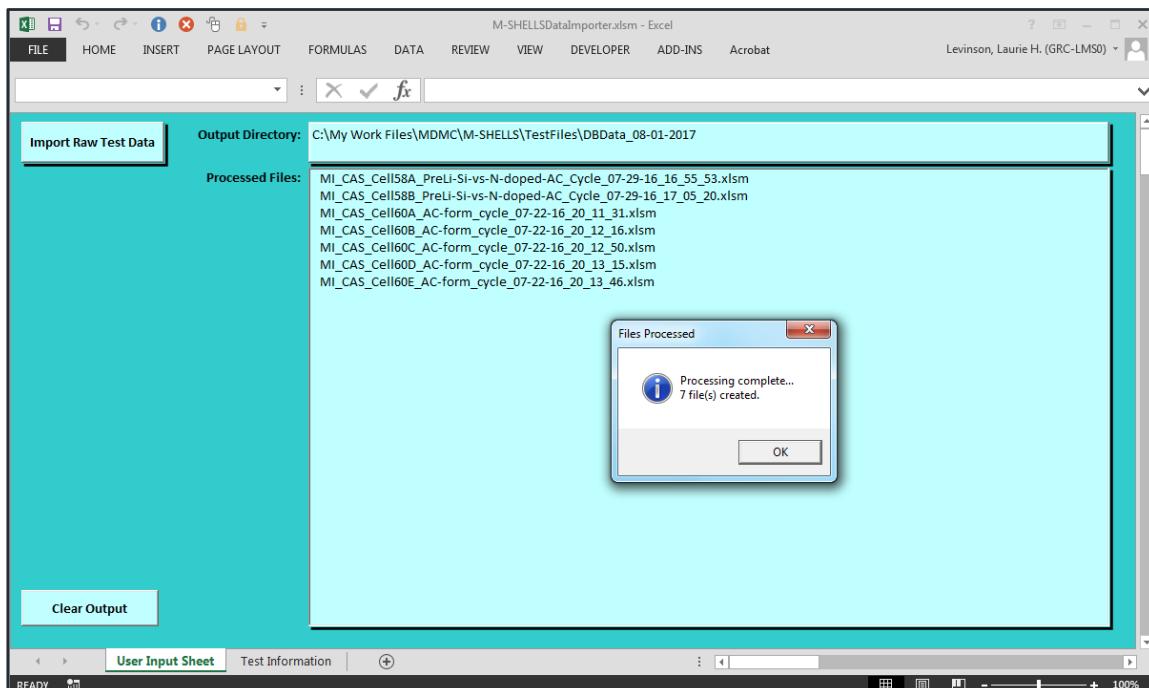


Figure 5. M-SHELLS User Interface Display Following Data Import Processing

### **Message Dialogs**

The automation software included in the M-SHELLS importer template includes robust error handling logic to address error conditions that may occur during a run. Therefore, while processing raw data files and saving the resulting output to importer template-based files ready for upload to the **Test Data**:

**Battery Performance** table of the MI database, a variety of warning messages may be displayed to the user. Some of the more common warning messages that may appear are described below.

#### **(A) Incomplete Processing Warning Message**

In the event of a run-time error during processing, an error message will be displayed to the user describing the error and identifying its source. In most cases, the user will then be given the option as to whether to attempt to continue processing the selected files despite the error, or to exit immediately in order to correct the problem prior to continuing (this will generally be the preferred response). If the user should choose to exit immediately, and processing of the relevant raw data files had begun but had not completed, a warning message will be displayed indicating that processing was terminated by the user prior to completion (see Figure 6).

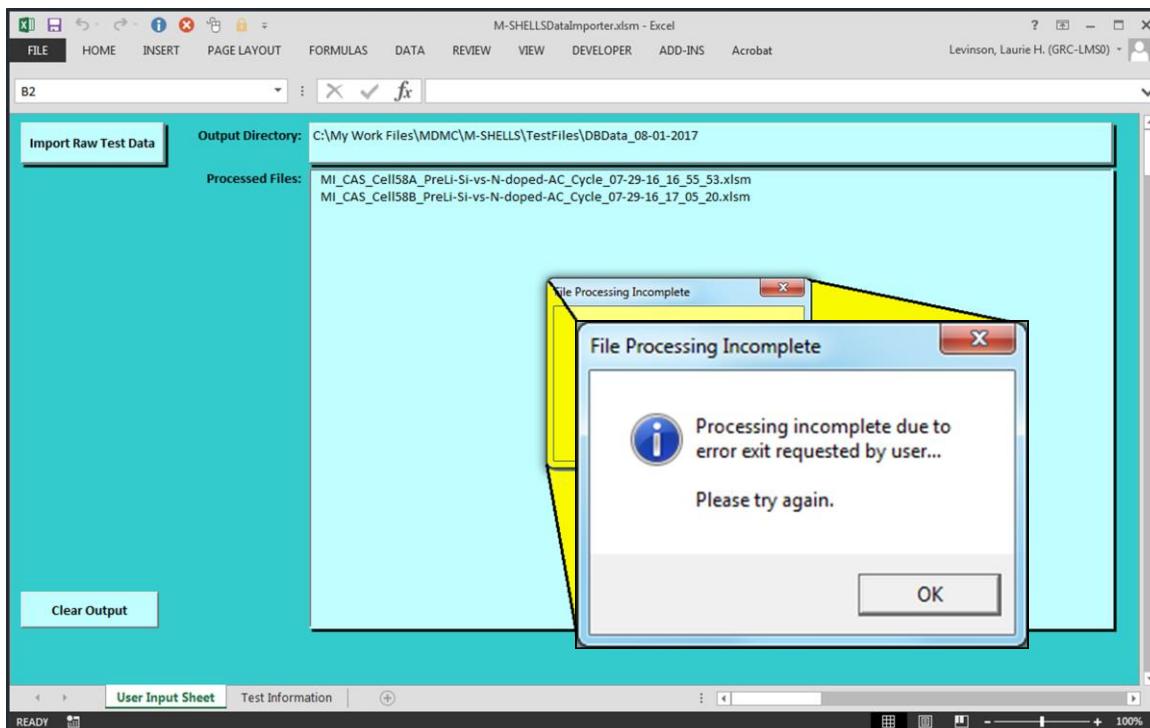


Figure 6. Error Exit Warning Message

#### **(B) File Name Conflict Warning Message**

If, while attempting to save processed raw data to an importer template-based workbook, a file is found to already exist in the output directory with the same name as the file to be saved (due, for example, to a prior attempt to process a group of related raw data files that was interrupted prior to completion due to an error), a warning message will be displayed informing the user of the file name conflict, and requesting user input as to how to resolve the conflict. (See Figure 7.)

In this situation, one of two options will be available to the user:

1. Select "Yes" to indicate that the previous file should be renamed by adding a unique suffix to that file's original file name prior to saving the new file; or
2. Select "No" to indicate that the previous file should be overwritten when saving the new file

In addition to enabling the user to specify the manner in which the current file name conflict should be resolved, the warning dialog also includes a checkbox which, if checked, enables the user to specify that the current user response should be applied to any future file name conflicts that may occur during the run, canceling all future display of the warning dialog in that case. Note that the checkbox must be checked BEFORE clicking the dialog's "Yes" or "No" CommandButton to indicate how the file name conflict should be handled, as the dialog will close immediately upon clicking either CommandButton.

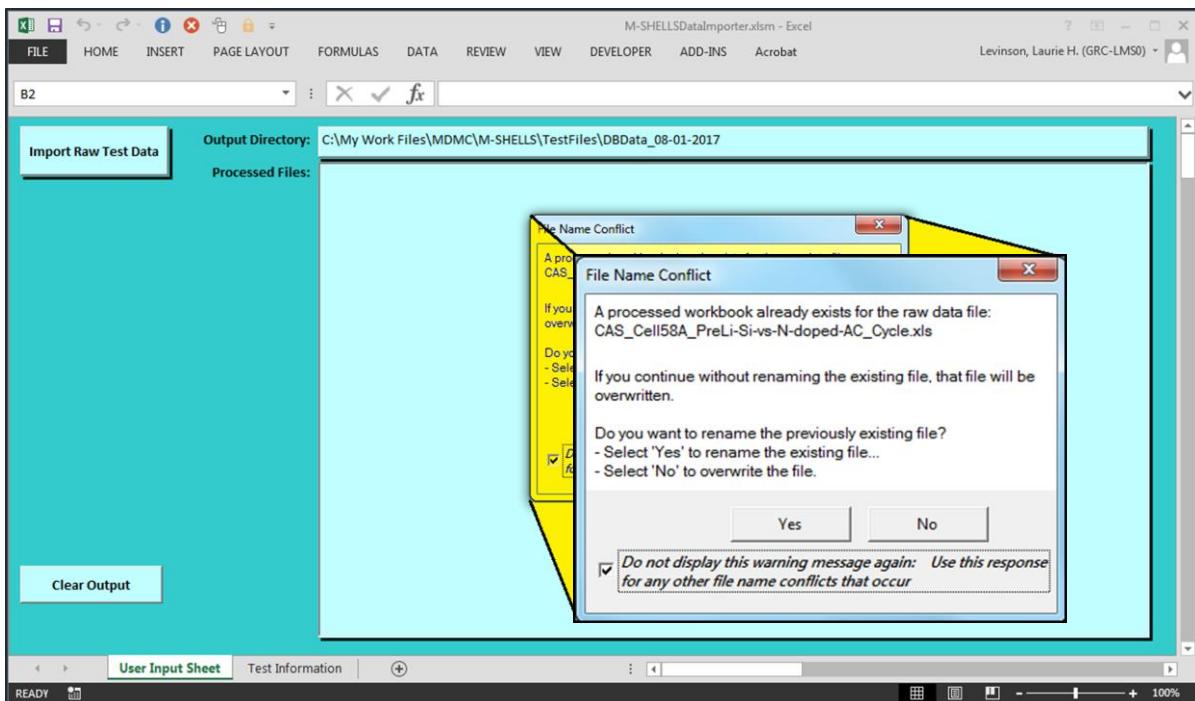


Figure 7. File Name Conflict Dialog

### (C) Renaming Open Workbook Informational Message

If, while attempting to output processed raw data to an importer template-based workbook, an open workbook is found to already exist in the output directory with the same name as the file to be saved, a warning message will be displayed informing the user that the currently open workbook is being renamed due to the file name conflict. (See Figure 8.) In addition to the basic message text, both the new file name for the renamed file, as well as the relevant output directory where the renamed file is located, will be provided.

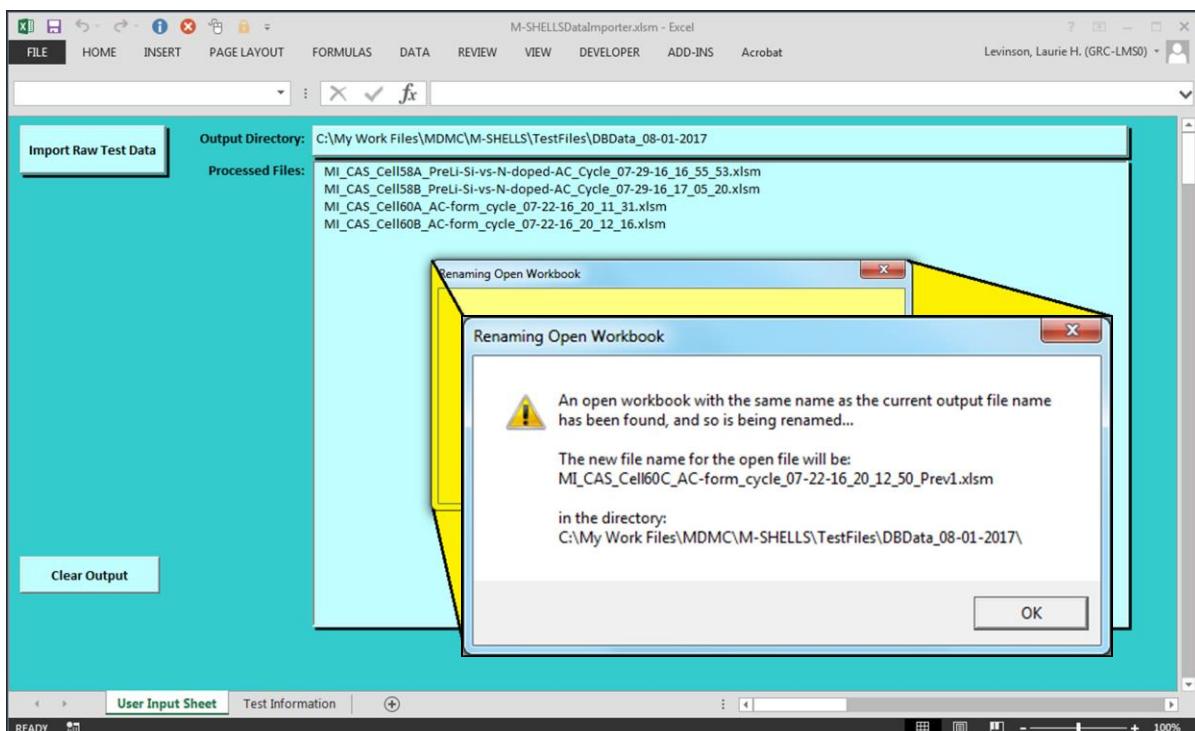


Figure 8. "Renaming Open Workbook" Message

#### (D) Output Path Too Long Warning Message

The maximum length for a full path specification that can be referenced within Excel, including the entire directory path, file name and file name extension, is 218 characters. If, while attempting to save an importer template-based file, it is determined that the default full path specification for the file to be output would exceed this limit, the output file name and/or output directory will be updated, as required, so that the full path specification for the output file no longer exceeds this limit. When performing this update, the output file name will first be shortened to the extent possible. Then, if necessary, the output directory will be updated, moving it up in the default output directory folder hierarchy to each parent directory until the full path specification is less than the 218 character limit. If this type of change should be required, a warning message will be displayed to the user which will include both the updated output directory name and the updated name of the processed file being output (see Figure 9). In addition, rather than listing the file name only, which is the default display, the file's full path specification will be displayed in the list of processed files included on the main page of the user **interface**.

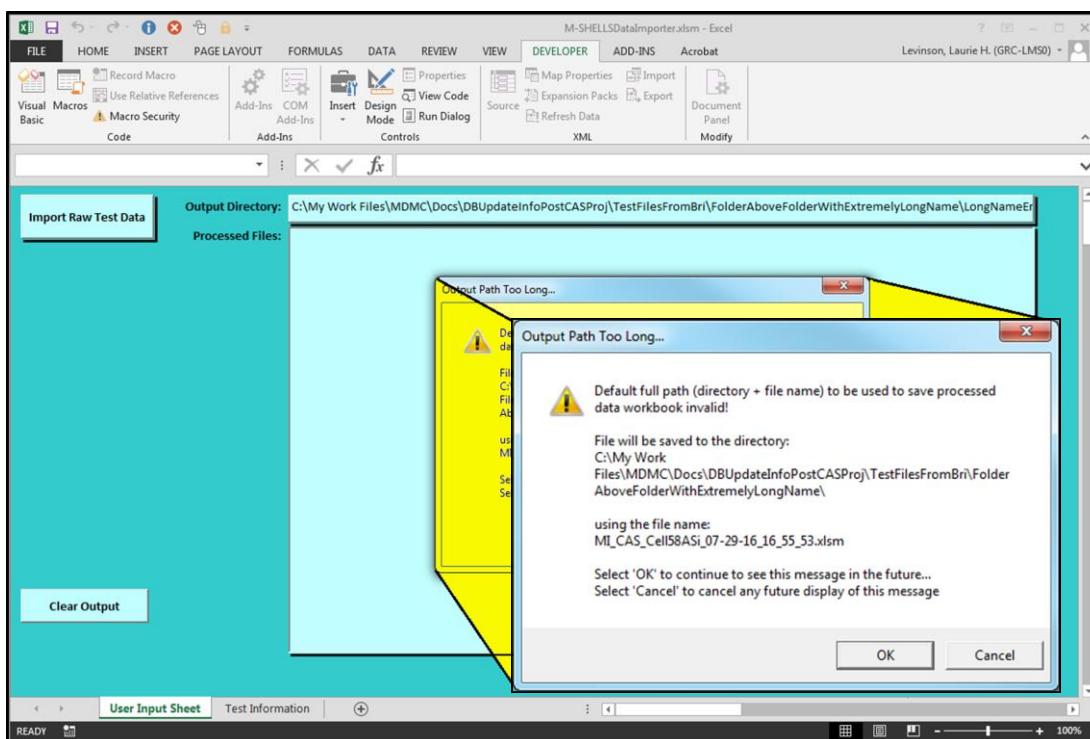


Figure 9. "Output Path Too Long" Warning Message

#### (E) Data Import Error / Input File Path Too Long Error Message

As the 218 character limit applies equally to input and output file names referenced from within Excel, a path specification that exceeds this limit may also occur for an input file either selected by the user, or identified during processing as an associated raw test data file. In either case, if the input file full path specification is found to exceed the permissible character limit, an error message will be displayed to the user, with the message text consisting of slightly different messages depending upon where in the process the problem has occurred, and thus the type of input file being referenced. If the error should occur while attempting to access a summary data file to obtain specimen data, the "Data Import Error" message will be displayed (Figure 10(a)). If, on the other hand, the summary data file is successfully accessed, but an attempt to retrieve an associated raw test data file should fail as a result of the path specification exceeding the limit, the "Input Path Too Long" error message will be displayed (Figure 10(b)). In either case, the user will be given the option of attempting to continue and process any relevant remaining files, or to exit

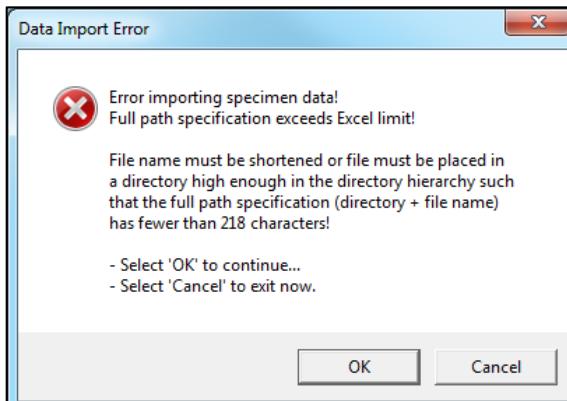


Figure 10(a). Error Message Displayed when Unable to Access Summary Data File

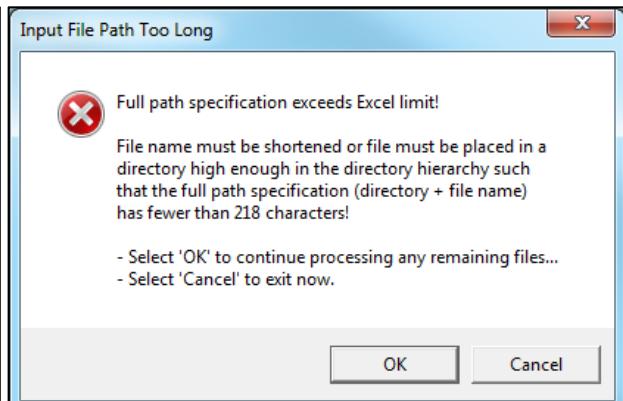


Figure 10(b). Error Message Displayed when Unable to Access Raw Test Data File

immediately. Regardless of which option is chosen by the user, however, before being able to successfully process any file(s) which caused the error to occur, the user will need to either rename the relevant file(s) and/or move them, along with any files that are to be processed at the same time, to another directory that will result in the full path specification for each file being less than the 218 character limit.

Note that, while attempting to process any input data file, if an error should occur *other than* as a result of the file path specification being too long, the “Data Import Error” message will likewise be displayed. In that case, the message text will indicate the type of input file that caused the error (specimen data or raw test data file), and will provide both the pre-defined run-time error number and a description of the error that has occurred.

## Input File Specifications

As stated in the “Overview” section of this document, the M-SHELLS data importer template and associated GUI are contained in the “**BatteryDataImporter.xlsxm**” Excel workbook, and are provided to facilitate the process of creating database upload-ready files that can be used to upload M-SHELLS data to the **Test Data: Battery Performance** table of the MI database. To initiate the process of creating these database upload-ready files, a “Browse...” dialog has been provided, activated by clicking the importer template GUI’s **Import Raw Test Data**” button. The user will then be able to browse to the appropriate directory and select the relevant summary data files, with each file containing the **“Cell #”** and corresponding pedigree data associated with the detailed raw test data files to be processed. All files containing these detailed test results **must** reside in the same directory as the corresponding summary data file, and will be automatically identified by the template software based upon the **“Cell #”** value specified. Each summary data file may include data from multiple test cells, with the **“Cell #”** and associated pedigree data for each cell listed on a separate line, following the format specifications described immediately below and in **Appendix A**. Files containing the detailed test results, in order to be properly identified by the automation software, **must** have file names of the form, “**CAS\_Cell[Cell\_ID]\*.xls†**”, where **[Cell\_ID]** is the **“Cell #”** value read from the summary data file, and **\*** and **†** may each be blank, or may be any text string consistent with valid Microsoft Windows file naming rules. If provided, the **\*** text string should begin with the **\_** (underscore) character, and will be interpreted by the software as a description of the type of test performed.

Additional details about each type of input file are included below, as well as in Appendices A and B.

### **(A) Summary (Specimen) Data File**

The required summary data file worksheet format is shown in Appendix A. While the software has been written to nominally be capable of handling summary data files with minor differences from the format described (e.g., additional or incorrectly ordered data columns, or columns with slight differences in the column header text), the only values that will be transferred to the processed,

template-based files in such a way as to be capable of being uploaded to the MI database are those values contained in the specified columns, as identified during the import process. The data to be imported **must** be located on a worksheet whose name includes the string, "**Pedigree**"; and the input file worksheet column headers must be consistent with the column header specifications as indicated in Appendix A in order for the data to be properly identified and imported. Following import, summary data file pedigree data will be displayed on the "**Pedigree Info**" worksheet of the corresponding template-based file, with selected values also displayed on the output file's "**Test Information**" worksheet and/or used to set values output to that worksheet.

#### **(B) Raw Test Data File**

During processing, test data from each of three pre-defined worksheets in each identified raw test data file will be imported and written out to a corresponding worksheet in the template-based output data file having the required format so as to enable the data to be uploaded to the MI database. Detailed format specifications for each of these three input file worksheets are provided in **Appendix B**. Note in particular that, unlike data imported from the summary data files, column headers for columns included in the raw test data files **must match exactly** the column headers listed in Appendix B, and the column headers also **must** be listed in the order indicated, with no intervening blank columns or blank cells in the column header row. In addition, each worksheet in the input file must have a worksheet name which **uniquely matches** the expected worksheet name format, as specified below, in order for the associated raw test data to be properly identified. The naming requirements for each of these worksheets, as well as the name of the corresponding worksheet in the template-based output file, are as follows:

1. Raw test data from the worksheet whose name includes the string, "**Info**" will be output to the "**Global\_Info\_Data**" worksheet in the template-based file;
2. Raw test data from the worksheet whose name includes the string "**Channel\_**" will be output to the "**Channel\_Data**" worksheet in the template-based file; and
3. Raw test data from the worksheet whose name includes the string "**Statistics\_**" will be output to the "**Statistics\_Data**" worksheet in the template-based file.

### **Output File Specifications**

As stated in an earlier section of this document, template-based output files are placed, by default, in a subdirectory of the directory where the raw test data input files are located, using a directory name of the form, "**DBData\_[mm-dd-yyyy]**", with the included date representing the current date at the time the data is being imported. If the indicated directory does not already exist, it will be created. Output files will be given a file name of the form, "**MI\_[source\_file\_name]\_[mm-dd-yy]\_[hh\_mm\_ss].xlsm**", with the date and time taken either from the "**Start Date/Time**" field on the template-based file's "**Global\_Info\_Data**" worksheet or, if that field is empty, from the original raw test data file's timestamp. Each template-based file will include a "**Pedigree Info**," "**Global\_Info\_Data**," "**Channel\_Data**," and "**Statistics\_Data**," worksheet, with each worksheet containing data imported from the corresponding summary data or detailed raw test data file worksheet, as described above and in Appendices A and B. For each of these output file worksheets, although the output file column header text may differ slightly from that specified for the associated input file column header, the column order and associated data in the output file will match the column order and data as displayed in **Appendix A**, for the "**Pedigree Info**" worksheet, and in **Appendix B**, for the three remaining worksheets. In addition, each output file will also include a "**Test Information**" worksheet, with data format and data derivation specifications as indicated in **Appendix C**. The "**Test Information**" worksheet displays selected data imported from the relevant summary data or raw test data file and displayed elsewhere within the template-based output file. It also includes values derived from imported data and/or user input provided during processing and determined based upon those values via the automation software, as well as miscellaneous other test information that may be relevant. The remaining values may be provided manually, or values may be modified from a pre-defined default, as appropriate, by the user. To add or modify the relevant values, the user may either enter each item individually, directly on the output file's "**Test Information**" worksheet, or optionally, use the "**Copy**" button provided at the top of the worksheet to copy missing values from a previously completed "**Test**

Information" worksheet in another workbook. To use this "Copy" function, both the workbook to be updated AND the source data workbook must be open within Excel. The user will then be able to use the "Copy From" dropdown box to select the relevant source data workbook, before clicking the "Copy" button to perform the update. Note that, when using the "Copy" button, no values from the "Test Results" section of the source worksheet will be copied, since those values reflect individual test results from a particular test, and so are unlikely to be the same from one workbook to another. In addition, as mentioned previously, in order to prevent Excel from prompting the user to ask whether to save changes any time a template-based file is being closed, even when no changes have been made to the file by the user, the warning prompt within Excel used to notify the user when a file is about to be closed with unsaved changes, has been disabled for all template-based files. Therefore, if any changes *have been* made that are to be saved, the user **must** remember to save the updated workbook before exiting, as no warning message will prompt the user prior to closing an updated file.

Also included on the "Test Information" worksheet, in the top left-hand corner, is a button that can be used to toggle the visibility state of empty data columns on the "Pedigree Info," "Global\_Info\_Data," "Channel\_Data," and "Statistics\_Data" worksheets. These columns are hidden by default, and the worksheets locked to protect the integrity of the imported data. However, the provided button may be used to view the hidden columns, if desired.

In addition to the worksheets described above, each template-based output file also includes several other worksheets required either for the automation software to operate as intended or to properly interface with the MI database upload software. One of these worksheets, the "Import Options" worksheet, provides the ability to specify settings for a range of options available within the database upload software, including record placement specifications used to determine how records are to be added to the database. In the case of the M-SHELLS importer template, these record placement specifications have been set so as to identify a folder and record hierarchy for M-SHELLS data that is consistent with M-SHELLS Project requirements. The settings therefore specify that records are to be added first to a folder based on the individual record's value for the "Test Data: Battery Performance" table's "Structure" attribute, i.e., either the "Half-Cell" or "Full-Cell" value, and then to the appropriate sub-folder within that folder based upon the value of the record's "Experiment No." attribute. The individual records are then listed within that folder based upon the value of the "Cell No." attribute. An example of this record hierarchy is illustrated in Figure 11.

The "Import Options" worksheet, as well as the other worksheets included for operational purposes, should never need to be modified by the user, and doing so could interfere with the proper operation of the importer template and/or the associated automation software. For this reason, these worksheets have been hidden from, and should not be accessed by, the user.

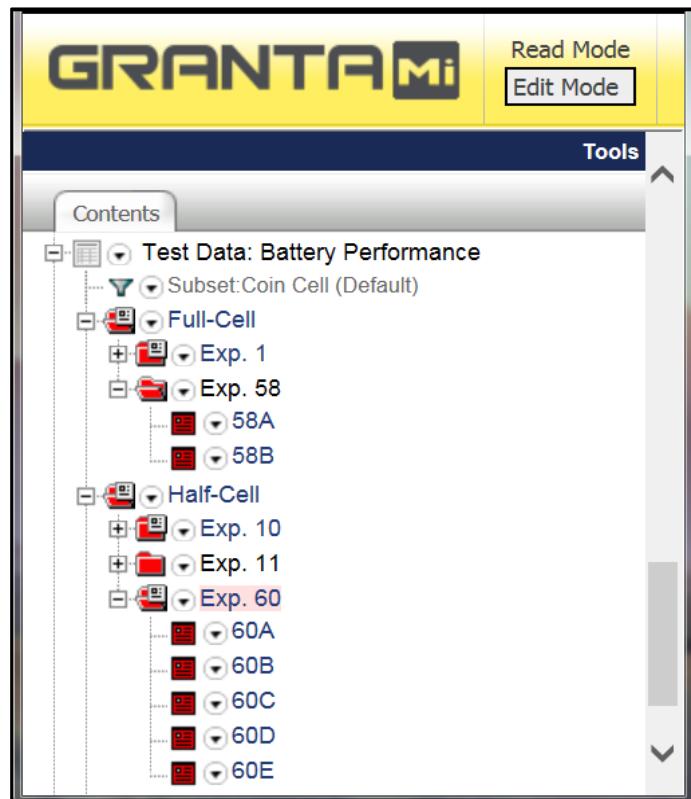
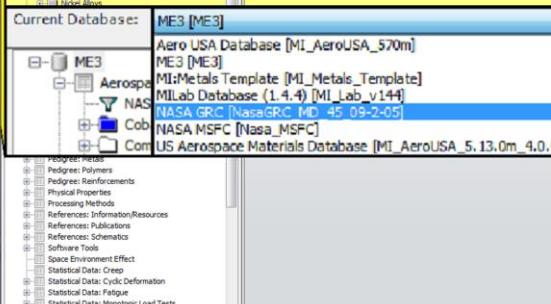


Figure 11. Test Data: Battery Performance Table Record Hierarchy

## **Uploading Data to the MI Database**

Uploading processed data to the MI Database is accomplished via the Granta-supplied **MI:Toolbox** application, installed on the user's computer. Upon program activation, a dialog will immediately be displayed requesting the user enter the address to be used to connect to the MI database server. The first time this dialog is displayed, the user will need to provide the appropriate server address, currently **gr2258769.ndc.nasa.gov**, ensuring also that the **"Use System Authentication"** CheckBox is checked (See Figure 12). Following this initial login, the prior settings will be restored each time **MI:Toolbox** is activated.

After completing the **MI: Toolbox** login, M-SHELLS data may be uploaded to the **Test Data: Battery Performance** database table using the following procedure:

1. Click on the “**Current Database**” DropDown arrow at the top right of the display and select the **NASA GRC** database (See Figure 13).
2. Click on the “**Import**” Toolbar button in the top left-hand corner (Figure 14(a), below) to display the Importer Plug-In Module Selection dialog box (Figure 14(b)).
3. Select the “**Excel Importer**” Plug-in option, and click “**Open**” (Figure 14(c)) to display the **Excel Importer** GUI (See Figure 15, below).
4. In the upper portion of the **Excel Importer** interface, on the right-hand side, click on the “**Browse**” button (Figure 16(a), below), and browse to the directory where the files to be uploaded are located. Select the relevant files, and then click the “**Open**” button. At this point, the file selection dialog will close, and the list of selected files will appear in the TextBox at the top of the GUI (Figure 16(b)).
5. Click on the blue arrow in the bottom right-hand corner of the **MI: Toolbox** GUI (Figure 16(c)), and the data upload will then begin.

As an alternative to the above procedure, it is also possible to upload data via the **GRANTA MI: Toolbox Excel Importer** command line interface. This option enables the user to create a batch file containing the appropriate commands, which can then be executed either manually, or installed as a scheduled task on the user's machine, performing the upload on a pre-determined basis. See the **"GRANTA MI:Toolbox Excel Importer Command-line Interface"** document for additional details.

## Viewing Uploaded Data

Once the user's data has been uploaded to the database, the data may be viewed by opening the web browser of the user's choice and navigating to the GRANTA MI database homepage via the URL,

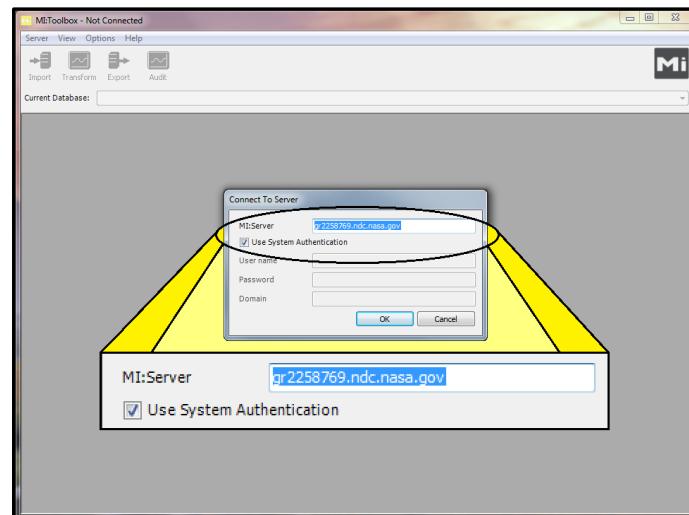


Figure 12. MI: Toolbox Login Screen

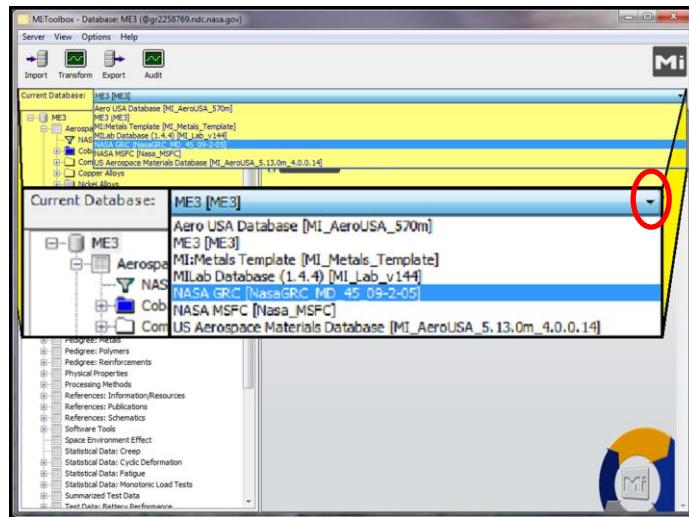


Figure 13. Database Selection within **MI: Toolbox**

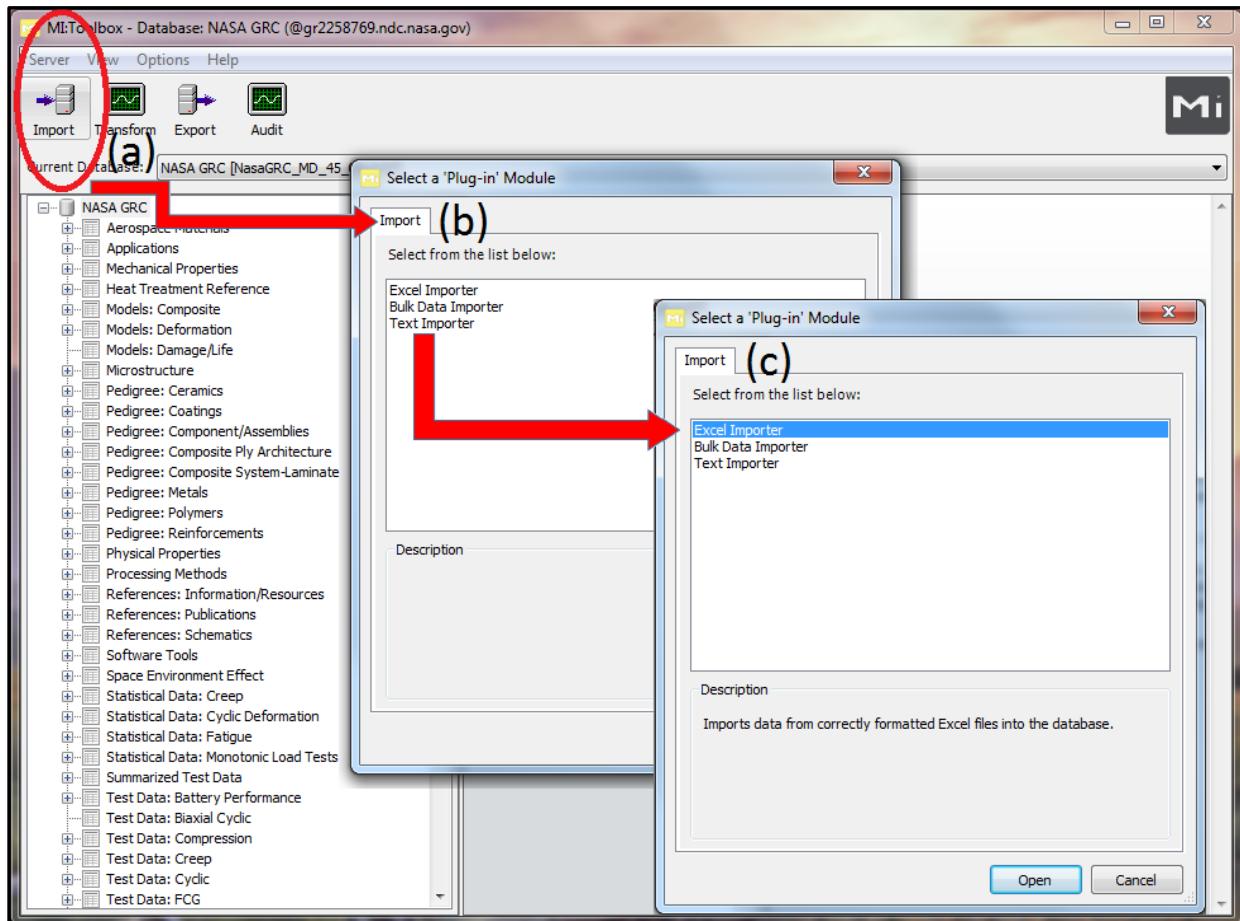


Figure 14. MI: Toolbox Excel Importer Selection Process

<http://gr2258769.ndc.nasa.gov/mi/>. Due to web browser differences, after entering this URL into the address bar, the system response will vary based upon the specific browser being used. With some browsers, the user will immediately be prompted to enter their login information; with others, the MI Database master homepage will first be displayed. In the latter case, once the master homepage appears, clicking on the “**NASA GRC Database**” icon, or any of the icons associated with the individual tabs of the GRC Database GUI (“**Materials**,” “**Models**,” “**Software Tools**,” etc.), will bring up a dialog enabling the user to log in. To complete the login process, the same information as used when logging in to the user’s desktop should be provided – using either the Smartcard login option, if available, or the standard username and password.

After logging in, left-clicking on the **Test Data: Battery Performance** table name, or the corresponding “+” sign immediately to the left of the table name, in the left-hand frame of the web page (“the tree”), will expand the tree node, displaying the name of the currently

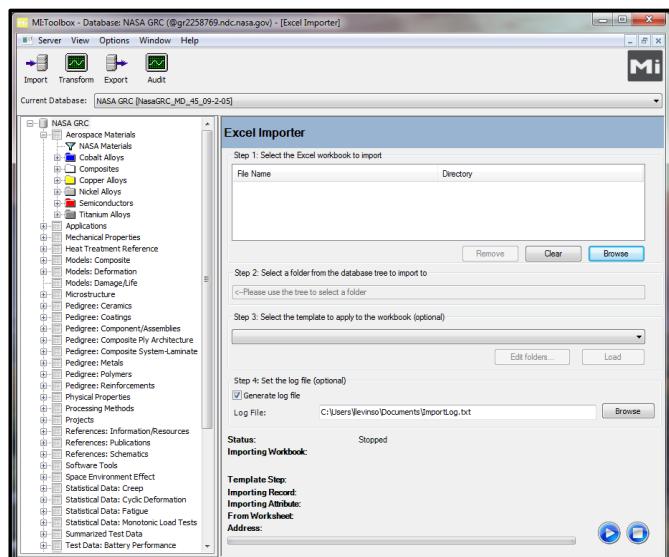


Figure 15. MI: Toolbox Excel Importer GUI

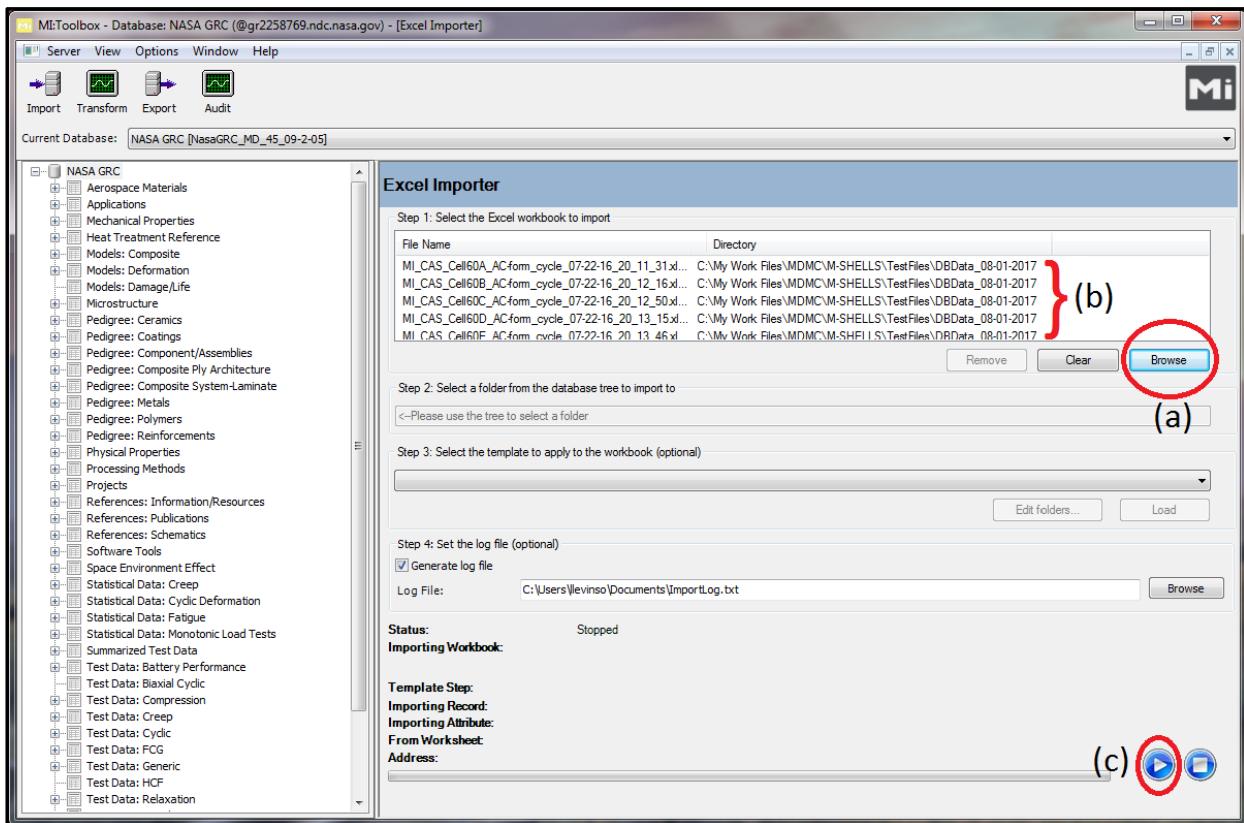


Figure 16. File Selection and Data Upload Initiation via MI: Toolbox Excel Importer

selected data subset, as well as the set of folders specified at the highest level of the table's folder hierarchy. If more than one subset has been specified, enabling differing data layouts to be utilized under different circumstances, the selected subset may be updated by left-clicking on the dropdown arrow next to the name of the current subset and selecting the desired subset (the default selection is the “**Coin Cell**” subset). Once the appropriate subset has been selected, left-clicking on the “+” sign associated with each folder in the tree at the next lower level of the hierarchy, or clicking on the associated folder name, to expand each corresponding node, will ultimately enable the user to view the list of records associated with the selected folder hierarchy. At this point, left-clicking on the record icon to the left of the record name, or clicking on the record name itself, will display the corresponding data. An additional set of menu options will then appear at the top right of the web browser window frame displaying the data, immediately above the record header identifying the record. These additional menu options may be used to modify the display according to the user's preferences, or to perform other associated tasks, such as exporting record data to a file.

Note that attribute names for attributes displayed in the database, in some cases, will differ somewhat from the names used for the corresponding data in the processed Excel data files used to upload data to the database. The mapping of database attribute names to their corresponding Excel file source data names and locations, however, is provided in Table 1, below.

Table 1. Mapping of Database Attributes to Excel Template-Based Source File Data

Database Attribute Name	Corresponding Excel File Source Data Cell Label(s) / Column Header(s)	Source Worksheet	Source Cell / Column
Test Description	Test Description	Test Information	E14:H14
Experiment No.	Experiment No.	Test Information	E15
Testing Standard	Testing Standard	Test Information	E16

Database Attribute Name	Corresponding Excel File Source Data Cell Label(s) / Column Header(s)	Source Worksheet	Source Cell / Column
Test Operator	Test Operator	Test Information	E17
Test Machine	Test Machine	Test Information	E18
Channel	Channel	Global_Info_Data	A5 <sup>†</sup>
Date Test Performed	Date Test Performed	Test Information	E19
Original Data Filename	Original Data Filename	Test Information	E20:H20
Valid Test?	---	---	---
Testing Notes	Testing Notes	Test Information	E21:H21
Cell No.	Cell No.	Test Information	E25
Cell Type	Cell Type	Test Information	E26
[ Cell Type ] No. of Layers	No. of Layers	Test Information	E27
Cell Type (Other)	Cell Type (Other)	Test Information	E28
Structure	Structure	Test Information	E29
Anode Diameter	Anode Diameter	Test Information	E30
Cathode Diameter	Cathode Diameter	Test Information	E31
Separator Diameter	Separator Diameter	Test Information	E32
Cell Thickness	Cell Thickness	Test Information	E33
[ Cell Thickness ] Anode Thickness	Anode Thickness	Test Information	E34
[ Cell Thickness ] Cathode Thickness	Cathode Thickness	Test Information	E35
[ Cell Thickness ] Separator Thickness	Separator Thickness	Test Information	E36
Cell Weight	Cell Weight	Test Information	E37
Test System Notes	Test System Notes	Test Information	E38
Anode Material	Anode Material	Test Information	E42
Anode Material ID	Anode Material ID	Test Information	E43
Anode % Active Material	Anode % Active Material	Test Information	E44
Anode Notes	Anode Notes	Test Information	E45
Cathode Material	Cathode Material	Test Information	E49
Cathode Material ID	Cathode Material ID	Test Information	E50
Cathode % Active Material	Cathode % Active Material	Test Information	E51
Cathode Notes	Cathode Notes	Test Information	E52
Anode Substrate Material	Anode Substrate Material	Test Information	E57
Cathode Substrate Material	Cathode Substrate Material	Test Information	E58
Separator Material	Separator Material	Test Information	E62
Separator Material ID	Separator Material ID	Test Information	E63
Electrolyte	Electrolyte	Test Information	E64
Electrolyte Type ID	Electrolyte Type ID	Test Information	E65
Anode Active Weight	Anode Active Weight	Test Information	E69
[ Anode Active Weight ] Coating	Coating	Test Information	E70
[ Anode Active Weight ] Normalized	Normalized	Test Information	E71
Cathode Active Weight	Cathode Active Weight	Test Information	E72
[ Cathode Active Weight ] Coating	Coating	Test Information	E73

Database Attribute Name	Corresponding Excel File Source Data Cell Label(s) / Column Header(s)	Source Worksheet	Source Cell / Column
[ Cathode Active Weight ] Normalized	Normalized	Test Information	E74
Total Active Weight	Total Active Weight	Test Information	E75
Anode Substrate Weight	Anode Substrate Weight	Test Information	E79
Cathode Substrate Weight	Cathode Substrate Weight	Test Information	E80
Open Circuit Voltage	Open Circuit Voltage	Test Information	E84
Internal Resistance	Internal Resistance	Test Information	E85
Impedance	Impedance	Test Information	E86
Test Temperature	Test Temperature	Test Information	E90
Voltage Window	Voltage Window	Test Information	E91:F91
Test Condition Notes	Test Condition Notes	Test Information	E92
Nominal Voltage	Nominal Voltage	Test Information	E96
[ Nominal Voltage ] Vmin	Vmin	Test Information	E97
[ Nominal Voltage ] Vmax	Vmax	Test Information	E98
Specific Power	Specific Power	Test Information	E99
[ Specific Power ] Current	Current	Test Information	E100
Specific Energy	Specific Energy	Test Information	E101
[ Specific Energy ] Time	Time	Test Information	E102
Charge Energy	Charge Energy	Test Information	E103
Discharge Energy	Discharge Energy	Test Information	E104
Specific Discharge Capacity	Specific Discharge Capacity	Test Information	E105
Charge Capacity	Charge Capacity	Test Information	E106
Discharge Capacity	Discharge Capacity	Test Information	E107
Irreversible Capacity	Irreversible Capacity	Test Information	E108
Capacity Retention	Capacity Retention	Test Information	E109
Energy Efficiency	Energy Efficiency	Test Information	E110
Coulombic Efficiency	Coulombic Efficiency	Test Information	E111
Analysis Notes	Analysis Notes	Test Information	E112
Half-Cell Summary	Cell No., Anode Material, Cathode Material, Specific Energy, Specific Power, Specific Discharge Capacity	Test Information	E25, E42, E49, E101, E99, E105
Full-Cell Summary	Cell No., Anode Material, Cathode Material, Specific Energy, Specific Power	Test Information	E25, E42, E49, E101, E99
Time Profile	Step Time(s) vs. Test Time(h)	Channel_Data	E vs. C
Test Profile	Step Index, Cycle Index vs. Test Time(h)	Channel_Data	F,G vs. C
Current vs Time	Current(A) vs. Test Time(h)	Channel_Data	H vs. C
Voltage vs Time	Voltage(V) vs. Test Time(h)	Channel_Data	J vs. C
Charge Capacity vs Time	Charge Capacity(Ah) vs. Test Time(h)	Channel_Data	K vs. C
Discharge Capacity vs Time	Discharge Capacity(Ah) vs. Test Time(h)	Channel_Data	S vs. C
Charge Energy vs Time	Charge Energy(Wh) vs. Test Time(h)	Channel_Data	AC vs. C
Discharge Energy vs Time	Discharge Energy(Wh) vs. Test Time(h)	Channel_Data	AK vs. C
Charge Time vs Cycle No.	Charge Time(s) vs. Cycle Index	Statistics_Data	AS vs. A

Database Attribute Name	Corresponding Excel File Source Data Cell Label(s) / Column Header(s)	Source Worksheet	Source Cell / Column
Discharge Time vs Cycle No.	Discharge Time(s) vs. Cycle Index	Statistics_Data	AT vs. A
Charge Capacity vs Cycle No.	Charge Capacity(Ah) vs. Cycle Index	Statistics_Data	H vs. A
Charge Energy vs Cycle No.	Charge Energy(Wh) vs. Cycle Index	Statistics_Data	Y vs. A
Discharge Capacity vs Cycle No.	Discharge Capacity(Ah) vs. Cycle Index	Statistics_Data	P vs. A
Discharge Energy vs Cycle No.	Discharge Energy(Wh) vs. Cycle Index	Statistics_Data	AG vs. A
Voltage vs Charge Capacity	Voltage(V) vs. Charge Capacity(Ah)	Channel_Data	J vs. K
Voltage vs Charge Energy	Voltage(V) vs. Charge Energy(Wh)	Channel_Data	J vs. AC
Voltage vs Discharge Capacity	Voltage(V) vs. Discharge Capacity(Ah)	Channel_Data	J vs. S
Voltage vs Discharge Energy	Voltage(V) vs. Discharge Energy(Wh)	Channel_Data	J vs. AK
Specific Charge Capacity (anode active) vs Time	Specific Charge Capacity (mAh/g-anode active) vs. Test Time(h)	Channel_Data	N vs. C
Specific Charge Capacity (anode) vs Time	Specific Charge Capacity (mAh/g-anode) vs. Test Time(h)	Channel_Data	L vs. C
Specific Charge Capacity (cathode active) vs Time	Specific Charge Capacity (mAh/g-cathode active) vs. Test Time(h)	Channel_Data	O vs. C
Specific Charge Capacity (cathode) vs Time	Specific Charge Capacity (mAh/g-cathode) vs. Test Time(h)	Channel_Data	M vs. C
Specific Charge Capacity (cell) vs Time	Specific Charge Capacity (mAh/g-cell) vs. Test Time(h)	Channel_Data	R vs. C
Specific Charge Capacity (total active) vs Time	Specific Charge Capacity (mAh/g-total active) vs. Test Time(h)	Channel_Data	Q vs. C
Specific Charge Capacity (total electrodes) vs Time	Specific Charge Capacity (mAh/g-total electrodes) vs. Test Time(h)	Channel_Data	P vs. C
Specific Discharge Capacity (anode active) vs Time	Specific Discharge Capacity (mAh/g-anode active) vs. Test Time(h)	Channel_Data	V vs. C
Specific Discharge Capacity (anode) vs Time	Specific Discharge Capacity (mAh/g-anode) vs. Test Time(h)	Channel_Data	T vs. C
Specific Discharge Capacity (cathode active) vs Time	Specific Discharge Capacity (mAh/g-cathode active) vs. Test Time(h)	Channel_Data	W vs. C
Specific Discharge Capacity (cathode) vs Time	Specific Discharge Capacity (mAh/g-cathode) vs. Test Time(h)	Channel_Data	U vs. C
Specific Discharge Capacity (cell) vs Time	Specific Discharge Capacity (mAh/g-cell) vs. Test Time(h)	Channel_Data	Z vs. C
Specific Discharge Capacity (total active) vs Time	Specific Discharge Capacity (mAh/g-total active) vs. Test Time(h)	Channel_Data	Y vs. C
Specific Discharge Capacity (total electrodes) vs Time	Specific Discharge Capacity (mAh/g-total electrodes) vs. Test Time(h)	Channel_Data	X vs. C
Inverse Coulombic Efficiency vs Time	Coulombic Efficiency (inverse %) vs. Test Time(h)	Channel_Data	AA vs. C
Coulombic Efficiency vs Time	Coulombic Efficiency (%) vs. Test Time(h)	Channel_Data	AB vs. C
Specific Charge Energy (anode active) vs Time	Specific Charge Energy (Wh/kg-anode active) vs. Test Time(h)	Channel_Data	AF vs. C
Specific Charge Energy (anode) vs Time	Specific Charge Energy (Wh/kg-anode) vs. Test Time(h)	Channel_Data	AD vs. C
Specific Charge Energy (cathode active) vs Time	Specific Charge Energy (Wh/kg-cathode active) vs. Test Time(h)	Channel_Data	AG vs. C

Database Attribute Name	Corresponding Excel File Source Data Cell Label(s) / Column Header(s)	Source Worksheet	Source Cell / Column
Specific Charge Energy (cathode) vs Time	Specific Charge Energy (Wh/kg-cathode) vs. Test Time(h)	Channel_Data	AE vs. C
Specific Charge Energy (cell) vs Time	Specific Charge Energy (Wh/kg-cell) vs. Test Time(h)	Channel_Data	AJ vs. C
Specific Charge Energy (total active) vs Time	Specific Charge Energy (Wh/kg-total active) vs. Test Time(h)	Channel_Data	AI vs. C
Specific Discharge Energy (anode active) vs Time	Specific Discharge Energy (Wh/kg-anode active) vs. Test Time(h)	Channel_Data	AN vs. C
Specific Discharge Energy (anode) vs Time	Specific Discharge Energy (Wh/kg-anode) vs. Test Time(h)	Channel_Data	AL vs. C
Specific Discharge Energy (cathode active) vs Time	Specific Discharge Energy (Wh/kg-cathode active) vs. Test Time(h)	Channel_Data	AO vs. C
Specific Discharge Energy (cathode) vs Time	Specific Discharge Energy (Wh/kg-cathode) vs. Test Time(h)	Channel_Data	AM vs. C
Specific Discharge Energy (cell) vs Time	Specific Discharge Energy (Wh/kg-cell) vs. Test Time(h)	Channel_Data	AR vs. C
Specific Discharge Energy (total active) vs Time	Specific Discharge Energy (Wh/kg-total active) vs. Test Time(h)	Channel_Data	AQ vs. C
Specific Discharge Energy (total electrodes) vs Time	Specific Discharge Energy (Wh/kg-total electrodes) vs. Test Time(h)	Channel_Data	AP vs. C
Inverse Energy Efficiency vs Time	Energy Efficiency (inverse %) vs. Test Time(h)	Channel_Data	AS vs. C
Energy Efficiency vs Time	Energy Efficiency (%) vs. Test Time(h)	Channel_Data	AT vs. C
Specific Charge Capacity (anode active) vs Cycle No.	Specific Charge Capacity (mAh/g-anode active) vs. Cycle Index	Statistics_Data	K vs. A
Specific Charge Capacity (anode) vs Cycle No.	Specific Charge Capacity (mAh/g-anode) vs. Cycle Index	Statistics_Data	I vs. A
Specific Charge Capacity (cathode active) vs Cycle No.	Specific Charge Capacity (mAh/g-cathode active) vs. Cycle Index	Statistics_Data	L vs. A
Specific Charge Capacity (cathode) vs Cycle No.	Specific Charge Capacity (mAh/g-cathode) vs. Cycle Index	Statistics_Data	J vs. A
Specific Charge Capacity (cell) vs Cycle No.	Specific Charge Capacity (mAh/g-cell) vs. Cycle Index	Statistics_Data	O vs. A
Specific Charge Capacity (total active) vs Cycle No.	Specific Charge Capacity (mAh/g-total active) vs. Cycle Index	Statistics_Data	N vs. A
Specific Charge Capacity (total electrodes) vs Cycle No.	Specific Charge Capacity (mAh/g-total electrodes) vs. Cycle Index	Statistics_Data	M vs. A
Specific Discharge Capacity (anode active) vs Cycle No.	Specific Discharge Capacity (mAh/g-anode active) vs. Cycle Index	Statistics_Data	S vs. A
Specific Discharge Capacity (anode) vs Cycle No.	Specific Discharge Capacity (mAh/g-anode) vs. Cycle Index	Statistics_Data	Q vs. A
Specific Discharge Capacity (cathode active) vs Cycle No.	Specific Discharge Capacity (mAh/g-cathode active) vs. Cycle Index	Statistics_Data	T vs. A
Specific Discharge Capacity (cathode) vs Cycle No.	Specific Discharge Capacity (mAh/g-cathode) vs. Cycle Index	Statistics_Data	R vs. A
Specific Discharge Capacity (cell) vs Cycle No.	Specific Discharge Capacity (mAh/g-cell) vs. Cycle Index	Statistics_Data	W vs. A

Database Attribute Name	Corresponding Excel File Source Data Cell Label(s) / Column Header(s)	Source Worksheet	Source Cell / Column
Specific Discharge Capacity (total active) vs Cycle No.	Specific Discharge Capacity (mAh/g-total active) vs. Cycle Index	Statistics_Data	V vs. A
Specific Discharge Capacity (total electrodes) vs Cycle No.	Specific Discharge Capacity (mAh/g-total electrodes) vs. Cycle Index	Statistics_Data	U vs. A
Capacity Retention vs Cycle No.	Capacity Retention (%) vs. Cycle Index	Statistics_Data	X vs. A
Specific Charge Energy (anode active) vs Cycle No.	Specific Charge Energy (Wh/kg-anode active) vs. Cycle Index	Statistics_Data	AB vs. A
Specific Charge Energy (anode) vs Cycle No.	Specific Charge Energy (Wh/kg-anode) vs. Cycle Index	Statistics_Data	Z vs. A
Specific Charge Energy (cathode active) vs Cycle No.	Specific Charge Energy (Wh/kg-cathode active) vs. Cycle Index	Statistics_Data	AC vs. A
Specific Charge Energy (cathode) vs Cycle No.	Specific Charge Energy (Wh/kg-cathode) vs. Cycle Index	Statistics_Data	AA vs. A
Specific Charge Energy (cell) vs Cycle No.	Specific Charge Energy (Wh/kg-cell) vs. Cycle Index	Statistics_Data	AF vs. A
Specific Charge Energy (total active) vs Cycle No.	Specific Charge Energy (Wh/kg-total active) vs. Cycle Index	Statistics_Data	AE vs. A
Specific Discharge Energy (anode active) vs Cycle No.	Specific Discharge Energy (Wh/kg-anode active) vs. Cycle Index	Statistics_Data	AJ vs. A
Specific Discharge Energy (anode) vs Cycle No.	Specific Discharge Energy (Wh/kg-anode) vs. Cycle Index	Statistics_Data	AH vs. A
Specific Discharge Energy (cathode active) vs Cycle No.	Specific Discharge Energy (Wh/kg-cathode active) vs. Cycle Index	Statistics_Data	AK vs. A
Specific Discharge Energy (cathode) vs Cycle No.	Specific Discharge Energy (Wh/kg-cathode) vs. Cycle Index	Statistics_Data	AI vs. A
Specific Discharge Energy (cell) vs Cycle No.	Specific Discharge Energy (Wh/kg-cell) vs. Cycle Index	Statistics_Data	AN vs. A
Specific Discharge Energy (total active) vs Cycle No.	Specific Discharge Energy (Wh/kg-total active) vs. Cycle Index	Statistics_Data	AM vs. A
Specific Discharge Energy (total electrodes) vs Cycle No.	Specific Discharge Energy (Wh/kg-total electrodes) vs. Cycle Index	Statistics_Data	AL vs. A
Energy Retention vs Cycle No.	Energy Retention (%) vs. Cycle Index	Statistics_Data	AO vs. A
Specific Energy (total electrodes) vs Time	Specific Energy (Wh/kg-total electrodes) vs. Test Time(h)	Channel_Data	AH vs. C
Specific Energy (total electrodes) vs Cycle No.	Specific Energy (Wh/kg-total electrodes) vs. Cycle Index	Statistics_Data	AD vs. A
Testing Organization	Testing Organization	Test Information	E116
Funding Organization	Funding Organization	Test Information	E117
Project Name	Project Name	Test Information	E121
Contract No.	Contract No.	Test Information	E122

### Legend

[ Attribute\_Name ]

Parent Attribute Name

t

Default Location, Row Number May Vary

---

Available in Database Only

## **Appendix A**

### **Summary Data File Worksheet Layout**

## Data Imported to “Pedigree Info” Worksheet

Table A-1. Summary Data File Pedigree Worksheet Input Data Format Specification

Relative Column*	Expected Column Header	Column Header Keywords†
A (1)	Cell #	Cell #
B (2)	Anode Material	Anode Material
C (3)	Cathode Material	Cathode Material
D (4)	Anode Material #	Anode Material #
E (5)	Cathode Material #	Cathode Material #
F (6)	Anode Diameter (in)	Anode Diameter
G (7)	Cathode Diameter (in)	Cathode Diameter
H (8)	Anode Weight (mg)‡	Anode Weight
J (10)	Anode Substrate Material	Anode Substrate Material
I (9)	Cathode Weight (mg)‡	Cathode Weight
K (11)	Cathode Substrate Material	Cathode Substrate Material
L (12)	Anode Substrate Weight (mg)	Anode Substrate Weight
M (13)	Cathode Substrate Weight (mg)	Cathode Substrate Weight
N (14)	Anode Coating Weight (mg)	Anode Coating
O (15)	Cathode Coating Weight (mg)	Cathode Coating
P (16)	Normalized (by Area) Anode Weight (mg)	Normalized Anode
Q (17)	Normalized (by Area) Cathode Weight (mg)	Normalized Cathode
R (18)	Total Electrode Weight (mg)‡	Total Electrode Weight
S (19)	Anode Active Material (%)	Anode Active Material
T (20)	Cathode Active Material (%)	Cathode Active Material
U (21)	Anode Active Weight (mg)	Anode Active Weight
V (22)	Cathode Active Weight (mg)	Cathode Active Weight
W (23)	Total Active Weight (mg)	Total Active Weight
X (24)	Cell Open Circuit Voltage (V)	Cell Voltage
Y (25)	Cell Thickness (in)	Cell Thickness
Z (26)	Cell Weight (g)	Cell Weight

\* Pedigree data input may start in any column of the input file worksheet, so column indices are relative. The first column of data to be imported **must** contain the “**Cell #**” value, however, and is the only column which must always be present in the input file. The remaining columns should be listed in the order shown, and should have column headers which match exactly the column headers shown above.

†Keywords are the individual words which **must** be included in the column header text in order for the column’s data to be recognized, and thus properly imported. Although generally the case, the individual keywords are not required to be contiguous words within the associated column header text, and are used to identify the column **only** in the event that an exact match to the corresponding “Expected Column Header” text string has not been found in the input file.

‡These values (**Anode Weight (mg)**, **Cathode Weight (mg)**, and **Total Electrode Weight (mg)**) are not uploaded to the database as attributes themselves; however, their values are used in the determination of multiple values that are uploaded as database attributes. See Tables **B-3**, **B-6**, and **C-1**, below, for additional details.

## **Appendix B**

### **Raw Test Data File Worksheet Layouts**

## Data Imported to “Global\_Info\_Data” Worksheet

Table B-1. Input Data Format Specification for Test Data Imported to Template-Based File’s “Global\_Info\_Data” Worksheet

Column	Column Header Text
A	Channel
B	Start_DateTime
C	Schedule_File_Name
D	Creator
E	Comments
F	Software Version
G	Serial Number
H	Schedule Version
I	MASS
J	Specific Capacity
K	Capacity
L	Chan_Num
M	Item_ID
N	Volt
O	Temp
P	Pres
Q	PH
R	FR
S	ChanStat
T	Aux
U	SmartBty
V	Event
W	CAN
X	Grade
Y	Internal_Resistance(Ohm)
Z	Discharge_Capacity(Ah)
AA	Concentration
AB	Digital Input
AC	Digital Output
AD	Related Humidity

Data from columns with the above-listed column headers will be imported from the raw test data input file into the template-based file. While the “**Channel**” column, Column A, **must** be included in the raw data input file, any column other than the first may be omitted. For each column included, however, the column header text **must match exactly** the column header text specified above, and any columns included must be listed in the order shown. In addition, no column may be included which is **not** listed above, and no intervening blank columns, or intervening columns with header row cells that are blank, are permitted, as the import of data from the worksheet will terminate when the first blank header row cell is encountered. As a result, if included, each column specified must either be located in the column indicated above or in a preceding column. Note, however, that, while all columns shown above, if included in the input file, will be imported into the template-based file, only data from the first row immediately following the header row, and only the items from that row highlighted above, will be uploaded to the database during the subsequent upload process, as per M-SHELLS Project specifications.

## Data Imported to “Channel\_Data” Worksheet

The “**Channel\_Data**” worksheet includes data columns with data imported directly from the raw test data input file (Table B2), as well as data columns consisting of values which are calculated by the importer template software based upon values imported from the summary data and/or raw test data file (Table B3). While the column headers and/or data associated with the calculated values *may* be included in the raw test data input file – i.e., their inclusion will not adversely impact the ability to import the raw test data – it is not necessary to include them in the input file, and any data values included in those columns will be ignored, as the importer template software will calculate the values to be output to the final processed data file. If calculated value column headers are to be included in the raw test data input file, however, they **must** be listed in the order shown in Tables B3 and B4, below, with calculated values highlighted in yellow in Table B4. Likewise, columns imported directly from the raw test data input file must be listed in the order shown in Tables B2 and B4, with all calculated values and the Table B-2 attributes highlighted in yellow uploaded to the database. No intervening blank columns, or intervening columns with header row cells that are blank, are permitted on the source data worksheet, as the import of data from that worksheet will terminate when the first blank header row cell is encountered. Furthermore, as with all raw test data input file column headers, the column header text for each column included **must match exactly** the column header text specified, and there must be no columns included other than those indicated. As is the case with all three raw test data input file worksheets, Column A, the “**Data\_Point**” column in this case, **must** be included in the raw test data input file; however, any column other than the first may be omitted from the input file.

Table B-2. Input File Column Order Specification for Test Data Imported Directly to Template-Based File’s “Channel\_Data” Worksheet

Column (without calculated values included)	Column (with all calculated values included)	Column Header Text
A	A	Data_Point
B	B	Test_Time(s)
C	C	Test_Time(h)
D	D	Date_Time
E	E	Step_Time(s)
F	F	Step_Index
G	G	Cycle_Index
H	H	Current(A)
I	I	Current(mA)
J	J	Voltage(V)
K	K	Charge_Capacity(Ah)
L	S	Discharge_Capacity(Ah)
M	AC	Charge_Energy(Wh)
N	AK	Discharge_Energy(Wh)
O	AU	dV/dt(V/s)
P	AV	Internal_Resistance(Ohm)
Q	AW	Is_FC_Data
R	AX	AC_Impedance(Ohm)
S	AY	ACI_Phase_Angle(Deg)
T	AZ	Cycle_Time

Table B-3. Specifications for Calculated Values Output to Template-Based File's "Channel\_Data" Worksheet and Optionally Included in Raw Test Data Input File

Column	Column Header Text	Calculation
L	Specific Charge Capacity (mAh / g-anode)	$(\text{Charge Capacity(Ah}) * 1000) / (\text{Anode weight (mg})/1000)$
M	Specific Charge Capacity (mAh / g-cathode)	$(\text{Charge Capacity(Ah}) * 1000) / (\text{Cathode Weight (mg})/1000)$
N	Specific Charge Capacity (mAh / g-anode active)	$(\text{Charge Capacity(Ah}) * 1000) / (\text{Anode Active Weight (mg}) / 1000)$
O	Specific Charge Capacity (mAh / g-cathode active)	$(\text{Charge Capacity(Ah}) * 1000) / (\text{Cathode Active Weight (mg}) / 1000)$
P	Specific Charge Capacity (mAh / g-total electrodes)	$(\text{Charge Capacity(Ah}) * 1000) / (\text{Total Electrode Weight (mg}) / 1000)$
Q	Specific Charge Capacity (mAh / g-total active)	$(\text{Charge Capacity(Ah}) * 1000) / (\text{Total Active Weight (mg}) / 1000)$
R	Specific Charge Capacity (mAh / g-cell)	$(\text{Charge Capacity(Ah}) * 1000) / (\text{Cell Weight (g})$
T	Specific Discharge Capacity (mAh / g-anode)	$(\text{Discharge Capacity(Ah}) * 1000) / (\text{Anode weight (mg})/1000)$
U	Specific Discharge Capacity (mAh / g-cathode)	$(\text{Discharge Capacity(Ah}) * 1000) / (\text{Cathode Weight (mg})/1000)$
V	Specific Discharge Capacity (mAh / g-anode active)	$(\text{Discharge Capacity(Ah}) * 1000) / (\text{Anode Active Weight (mg}) / 1000)$
W	Specific Discharge Capacity (mAh / g-cathode active)	$(\text{Discharge Capacity(Ah}) * 1000) / (\text{Cathode Active Weight (mg}) / 1000)$
X	Specific Discharge Capacity (mAh / g-total electrodes)	$(\text{Discharge Capacity(Ah}) * 1000) / (\text{Total Electrode Weight (mg}) / 1000)$
Y	Specific Discharge Capacity (mAh / g-total active)	$(\text{Discharge Capacity(Ah}) * 1000) / (\text{Total Active Weight (mg}) / 1000)$
Z	Specific Discharge Capacity (mAh / g-cell)	$(\text{Discharge Capacity(Ah}) * 1000) / (\text{Cell Weight (g})$
AA	Coulombic Efficiency (inverse %)	$(\text{Charge Capacity(Ah}) / \text{Discharge Capacity(Ah}) * 100$
AB	Coulombic Efficiency (%)	$(\text{Discharge Capacity(Ah}) / \text{Charge Capacity(Ah}) * 100$
AD	Specific Charge Energy (Wh/kg-anode)	$(\text{Charge Energy(Wh}) * 1000) / (\text{Anode weight (mg})/1000)$
AE	Specific Charge Energy (Wh/kg-cathode)	$(\text{Charge Energy(Wh}) * 1000) / (\text{Cathode Weight (mg})/1000)$
AF	Specific Charge Energy (Wh/kg-anode active)	$(\text{Charge Energy(Wh}) * 1000) / (\text{Anode Active Weight (mg}) / 1000)$
AG	Specific Charge Energy (Wh/kg-cathode active)	$(\text{Charge Energy(Wh}) * 1000) / (\text{Cathode Active Weight (mg}) / 1000)$
AH	Specific Energy (Wh/kg-total electrodes)	$(\text{Charge Energy(Wh}) * 1000) / (\text{Total Electrode Weight (mg}) / 1000)$
AI	Specific Charge Energy (Wh/kg-total active)	$(\text{Charge Energy(Wh}) * 1000) / (\text{Total Active Weight (mg}) / 1000)$
AJ	Specific Charge Energy (Wh/kg-cell)	$(\text{Charge Energy(Wh}) * 1000) / (\text{Cell Weight (g})$
AL	Specific Discharge Energy (Wh/kg-anode)	$(\text{Discharge Energy(Wh}) * 1000) / (\text{Anode weight (mg})/1000)$
AM	Specific Discharge Energy (Wh/kg-cathode)	$(\text{Discharge Energy(Wh}) * 1000) / (\text{Cathode Weight (mg})/1000)$
AN	Specific Discharge Energy (Wh/kg-anode active)	$(\text{Discharge Energy(Wh}) * 1000) / (\text{Anode Active Weight (mg}) / 1000)$
AO	Specific Discharge Energy (Wh/kg-cathode active)	$(\text{Discharge Energy(Wh}) * 1000) / (\text{Cathode Active Weight (mg}) / 1000)$
AP	Specific Discharge Energy (Wh/kg-total electrodes)	$(\text{Discharge Energy(Wh}) * 1000) / (\text{Total Electrode Weight (mg}) / 1000)$
AQ	Specific Discharge Energy (Wh/kg-total active)	$(\text{Discharge Energy(Wh}) * 1000) / (\text{Total Active Weight (mg}) / 1000)$
AR	Specific Discharge Energy (Wh/kg-cell)	$(\text{Discharge Energy(Wh}) * 1000) / (\text{Cell Weight (g})$
AS	Energy Efficiency (inverse %)	$\text{Charge Energy(Wh}) / \text{Discharge Energy(Wh}) * 100$
AT	Energy Efficiency (%)	$\text{Discharge Energy(Wh}) / \text{Charge Energy(Wh}) * 100$

Table B-4. Column Order Specification for Data Displayed on Template-Based File's "Channel\_Data" Worksheet (Calculated Values Highlighted in Yellow)

Column	Column Header Text
A	Data_Point
B	Test_Time(s)
C	Date_Time
D	Test_Time(h)
E	Step_Time(s)
F	Step_Index
G	Cycle_Index
H	Current(A)
I	Current(mA)
J	Voltage(V)
K	Charge_Capacity(Ah)
L	Specific Charge Capacity (mAh/g-anode)
M	Specific Charge Capacity (mAh/g-cathode)
N	Specific Charge Capacity (mAh/g-anode active)
O	Specific Charge Capacity (mAh/g-cathode active)
P	Specific Charge Capacity (mAh/g-total electrodes)
Q	Specific Charge Capacity (mAh/g-total active)
R	Specific Charge Capacity (mAh/g-cell)
S	Discharge_Capacity(Ah)
T	Specific Discharge Capacity (mAh/g-anode)
U	Specific Discharge Capacity (mAh/g-cathode)
V	Specific Discharge Capacity (mAh/g-anode active)
W	Specific Discharge Capacity (mAh/g-cathode active)
X	Specific Discharge Capacity (mAh/g-total electrodes)
Y	Specific Discharge Capacity (mAh/g-total active)
Z	Specific Discharge Capacity (mAh/g-cell)
AA	Coulombic Efficiency (inverse %)
AB	Coulombic Efficiency (%)
AC	Charge_Energy(Wh)
AD	Specific Charge Energy (Wh/kg-anode)
AE	Specific Charge Energy (Wh/kg-cathode)
AF	Specific Charge Energy (Wh/kg-anode active)
AG	Specific Charge Energy (Wh/kg-cathode active)
AH	Specific Energy (Wh/kg-total electrodes)
AI	Specific Charge Energy (Wh/kg-total active)
AJ	Specific Charge Energy (Wh/kg-cell)
AK	Discharge_Energy(Wh)
AL	Specific Discharge Energy (Wh/kg-anode)
AM	Specific Discharge Energy (Wh/kg-cathode)
AN	Specific Discharge Energy (Wh/kg-anode active)
AO	Specific Discharge Energy (Wh/kg-cathode active)
AP	Specific Discharge Energy (Wh/kg-total electrodes)
AQ	Specific Discharge Energy (Wh/kg-total active)
AR	Specific Discharge Energy (Wh/kg-cell)
AS	Energy Efficiency (inverse %)
AT	Energy Efficiency (%)
AU	dV/dt(V/s)
AV	Internal_Resistance(Ohm)
AW	Is_FC_Data
AX	AC_Impedance(Ohm)
AY	ACI_Phase_Angle(Deg)
AZ	Cycle_Time

## Data Imported to “Statistics\_Data” Worksheet

As with the “**Channel\_Data**” worksheet, the “**Statistics\_Data**” worksheet in template-based files includes data columns both directly imported from the raw test data input file (Table B5), as well as data columns consisting of values which are calculated by the importer template software based upon values imported from the summary data and/or raw test data files (Table B6). Similarly, as for the “**Channel\_Data**” worksheet, while the column headers and/or data associated with the calculated values *may* be included in the raw test data input file – i.e., their inclusion will not adversely impact the ability to import the raw test data – it is not necessary to include them in the input file, and any data values included in those columns will be ignored, as the values output to the final processed data files will be calculated by the software. If calculated value column headers are to be included in the raw test data input file, however, they **must** be listed in the order shown in Tables B6 and B7, below, with calculated values highlighted in yellow in Table B7. Likewise, columns imported directly from the raw test data input file must be listed in the order shown in Tables B5 and B6, with all calculated values, and the Table B-5 attributes highlighted in yellow uploaded to the database. In addition, no intervening blank columns, or intervening columns with header row cells that are blank, are permitted, as the import of data from the worksheet will terminate when the first blank header row cell is encountered. Furthermore, as with all raw test data input file column headers, the column header text for each column included **must match exactly** the column header text specified, and there must be no columns included other than those indicated. As is the case with all three raw test data input file worksheets, Column A, the “**Cycle\_Index**” column in this case, **must** be included in the raw data input file; however, any column other than the first may be omitted from the input file.

Table B-5. Input File Column Order Specification for Test Data Imported Directly to Template-Based File’s “Statistics\_Data” Worksheet

Column (without calculated values included)	Column (with all calculated values included)	Column Header Text
A	A	Cycle_Index
B	B	Test_Time(s)
C	C	Test_Time(h)
D	D	Date_Time
E	E	Current(A)
F	F	Current(mA)
G	G	Voltage(V)
H	H	Charge_Capacity(Ah)
I	P	Discharge_Capacity(Ah)
J	Y	Charge_Energy(Wh)
K	AG	Discharge_Energy(Wh)
L	AP	Internal_Resistance(Ohm)
M	AQ	AC_Impedance(Ohm)
N	AR	ACI_Phase_Angle(Deg)
O	AS	Charge_Time(s)
P	AT	Discharge_Time(s)
Q	AU	Vmax_On_Cycle(V)

Table B-6. Specifications for Calculated Values Output to Template-Based File's "Statistics\_Data" Worksheet and Optionally Included in Raw Test Data Input File

Column	Column Header Text	Calculation
I	Specific Charge Capacity (mAh / g-anode)	$(\text{Charge Capacity(Ah)} * 1000) / (\text{Anode weight (mg)} / 1000)$
J	Specific Charge Capacity (mAh / g-cathode)	$(\text{Charge Capacity(Ah)} * 1000) / (\text{Cathode Weight (mg)} / 1000)$
K	Specific Charge Capacity (mAh / g-anode active)	$(\text{Charge Capacity(Ah)} * 1000) / (\text{Anode Active Weight (mg)} / 1000)$
L	Specific Charge Capacity (mAh / g-cathode active)	$(\text{Charge Capacity(Ah)} * 1000) / (\text{Cathode Active Weight (mg)} / 1000)$
M	Specific Charge Capacity (mAh / g-total electrodes)	$(\text{Charge Capacity(Ah)} * 1000) / (\text{Total Electrode Weight (mg)} / 1000)$
N	Specific Charge Capacity (mAh / g-total active)	$(\text{Charge Capacity(Ah)} * 1000) / (\text{Total Active Weight (mg)} / 1000)$
O	Specific Charge Capacity (mAh / g-cell)	$(\text{Charge Capacity(Ah)} * 1000) / (\text{Cell Weight (g)})$
Q	Specific Discharge Capacity (mAh / g-anode)	$(\text{Discharge Capacity(Ah)} * 1000) / (\text{Anode weight (mg)} / 1000)$
R	Specific Discharge Capacity (mAh / g-cathode)	$(\text{Discharge Capacity(Ah)} * 1000) / (\text{Cathode Weight (mg)} / 1000)$
S	Specific Discharge Capacity (mAh / g-anode active)	$(\text{Discharge Capacity(Ah)} * 1000) / (\text{Anode Active Weight (mg)} / 1000)$
T	Specific Discharge Capacity (mAh / g-cathode active)	$(\text{Discharge Capacity(Ah)} * 1000) / (\text{Cathode Active Weight (mg)} / 1000)$
U	Specific Discharge Capacity (mAh / g-total electrodes)	$(\text{Discharge Capacity(Ah)} * 1000) / (\text{Total Electrode Weight (mg)} / 1000)$
V	Specific Discharge Capacity (mAh / g-total active)	$(\text{Discharge Capacity(Ah)} * 1000) / (\text{Total Active Weight (mg)} / 1000)$
W	Specific Discharge Capacity (mAh / g-cell)	$(\text{Discharge Capacity(Ah)} * 1000) / (\text{Cell Weight (g)})$
X	Capacity Retention (%)	$(\text{Discharge Capacity(Ah)} / \text{Initial Discharge_Capacity(Ah)}) * 100$
Z	Specific Charge Energy (Wh / kg-anode)	$(\text{Charge Energy(Wh)} * 1000) / (\text{Anode weight (mg)} / 1000)$
AA	Specific Charge Energy (Wh / kg-cathode)	$(\text{Charge Energy(Wh)} * 1000) / (\text{Cathode Weight (mg)} / 1000)$
AB	Specific Charge Energy (Wh / kg-anode active)	$(\text{Charge Energy(Wh)} * 1000) / (\text{Anode Active Weight (mg)} / 1000)$
AC	Specific Charge Energy (Wh / kg-cathode active)	$(\text{Charge Energy(Wh)} * 1000) / (\text{Cathode Active Weight (mg)} / 1000)$
AD	Specific Energy (Wh / kg-total electrodes)	$(\text{Charge Energy(Wh)} * 1000) / (\text{Total Electrode Weight (mg)} / 1000)$
AE	Specific Charge Energy (Wh / kg-total active)	$(\text{Charge Energy(Wh)} * 1000) / (\text{Total Active Weight (mg)} / 1000)$
AF	Specific Charge Energy (Wh / kg-cell)	$(\text{Charge Energy(Wh)} * 1000) / (\text{Cell Weight (g)})$
AH	Specific Discharge Energy (Wh / kg-anode)	$(\text{Discharge Energy(Wh)} * 1000) / (\text{Anode weight (mg)} / 1000)$
AI	Specific Discharge Energy (Wh / kg-cathode)	$(\text{Discharge Energy(Wh)} * 1000) / (\text{Cathode Weight (mg)} / 1000)$
AJ	Specific Discharge Energy (Wh / kg-anode active)	$(\text{Discharge Energy(Wh)} * 1000) / (\text{Anode Active Weight (mg)} / 1000)$
AK	Specific Discharge Energy (Wh / kg-cathode active)	$(\text{Discharge Energy(Wh)} * 1000) / (\text{Cathode Active Weight (mg)} / 1000)$
AL	Specific Discharge Energy (Wh / kg-total electrodes)	$(\text{Discharge Energy(Wh)} * 1000) / (\text{Total Electrode Weight (mg)} / 1000)$
AM	Specific Discharge Energy (Wh / kg-total active)	$(\text{Discharge Energy(Wh)} * 1000) / (\text{Total Active Weight (mg)} / 1000)$
AN	Specific Discharge Energy (Wh / kg-cell)	$(\text{Discharge Energy(Wh)} * 1000) / (\text{Cell Weight (g)})$
AO	Energy Retention (%)	$\text{Discharge Energy(Wh)} / \text{Initial Discharge Energy(Wh)}$

Table B-7. Column Order Specification for Data Displayed on Template-Based File's "Statistics\_Data" Worksheet (Calculated Values Highlighted in Yellow)

Column	Column Header Text
A	Cycle_Index
B	Test_Time(s)
C	Test_Time(h)
D	Date_Time
E	Current(A)
F	Current(mA)
G	Voltage(V)
H	Charge_Capacity(Ah)
I	Specific Charge Capacity (mAh/g-anode)
J	Specific Charge Capacity (mAh/g-cathode)
K	Specific Charge Capacity (mAh/g-anode active)
L	Specific Charge Capacity (mAh/g-cathode active)
M	Specific Charge Capacity (mAh/g-total electrodes)
N	Specific Charge Capacity (mAh/g-total active)
O	Specific Charge Capacity (mAh/g-cell)
P	Discharge_Capacity(Ah)
Q	Specific Discharge Capacity (mAh/g-anode)
R	Specific Discharge Capacity (mAh/g-cathode)
S	Specific Discharge Capacity (mAh/g-anode active)
T	Specific Discharge Capacity (mAh/g-cathode active)
U	Specific Discharge Capacity (mAh/g-total electrodes)
V	Specific Discharge Capacity (mAh/g-total active)
W	Specific Discharge Capacity (mAh/g-cell)
X	Capacity Retention (%)
Y	Charge_Energy(Wh)
Z	Specific Charge Energy (Wh/kg-anode)
AA	Specific Charge Energy (Wh/kg-cathode)
AB	Specific Charge Energy (Wh/kg-anode active)
AC	Specific Charge Energy (Wh/kg-cathode active)
AD	Specific Energy (Wh/kg-total electrodes)
AE	Specific Charge Energy (Wh/kg-total active)
AF	Specific Charge Energy (Wh/kg-cell)
AG	Discharge_Energy(Wh)
AH	Specific Discharge Energy (Wh/kg-anode)
AI	Specific Discharge Energy (Wh/kg-cathode)
AJ	Specific Discharge Energy (Wh/kg-anode active)
AK	Specific Discharge Energy (Wh/kg-cathode active)
AL	Specific Discharge Energy (Wh/kg-total electrodes)
AM	Specific Discharge Energy (Wh/kg-total active)
AN	Specific Discharge Energy (Wh/kg-cell)
AO	Energy Retention (%)
AP	Internal_Resistance(Ohm)
AQ	AC_Impedance(Ohm)
AR	ACI_Phase_Angle(Deg)
AS	Charge_Time(s)
AT	Discharge_Time(s)
AU	Vmax_On_Cycle(V)

## **Appendix C**

### **Template-Based File “Test Information” Worksheet Specifications**

## Template-Based File “Test Information” Worksheet Layout, Part 1

Copy From :		Copy
Record Name	58A	
Short Name	58A	
<b>Test Information</b>		
<b>Test Description</b>	PreLi-Si-vs-N-doped-AC Cycle	
<b>Experiment No.</b>	58	
<b>Testing Standard</b>		
<b>Test Operator</b>		
<b>Test Machine</b>		
<b>Date Test Performed</b>	July 29, 2016	
<b>Original Data Filename</b>	CAS_Cell58A_PreLi-Si-vs-N-doped-AC_Cycle.xls	
<b>Testing Notes</b>		
<b>Cell Description</b>		
<b>Cell No.</b>	58A	
<b>Cell Type</b>	Coin	
<b>No. of Layers</b>		
<b>Cell Type (Other)</b>		
<b>Structure</b>	Full-Cell	
<b>Anode Diameter</b>	in	0.5
<b>Cathode Diameter</b>	in	6.25E-01
<b>Separator Diameter</b>	in	
<b>Cell Thickness</b>	in	
<b>Anode Thickness</b>	in	
<b>Cathode Thickness</b>	in	
<b>Separator Thickness</b>	in	
<b>Cell Weight</b>	g	
<b>Test System Notes</b>		
<b>Anode Coating Material</b>		
<b>Anode Material</b>	Pre-lithiated Silicon	
<b>Anode Material ID</b>	53	
<b>Anode % Active Material %</b>	85	
<b>Anode Notes</b>		
<b>Cathode Coating Material</b>		
<b>Cathode Material</b>	30-min N-doped MTI	
<b>Cathode Material ID</b>	54	
<b>Cathode % Active Material %</b>	915	
<b>Cathode Notes</b>		
<b>Electrode Substrate Materials</b>		
<b>Anode Substrate Material</b>	Copper	
<b>Cathode Substrate Material</b>	Aluminum	

Figure C-1. “Test Information” Worksheet Format for Template-based Files (Pt 1 of 2).

## Template-Based File “Test Information” Worksheet Layout, Part 2

Separator/Electrolyte Materials		
Separator Material	mg	
Separator Material ID	mg	
Electrolyte	mg	
Electrolyte Type ID	mg	
Active Electrode Weights		
Anode Active Weight	mg	5.78
Coating	mg	6.8
Normalized	mg	6.8
Cathode Active Weight	mg	2.89872
Coating	mg	4.95
Normalized	mg	3.168
Total Active Weight	mg	8.67872
Electrode Substrate Weights		
Anode Substrate Weight	mg	19.1
Cathode Substrate Weight	mg	8.05
Cell Electrical Characteristics		
Open Circuit Voltage	V	2.44
Internal Resistance	μΩ	
Impedance	Ω/cm	
Test Conditions		
Test Temperature	°F	
Voltage Window	V	
Test Condition Notes		
Test Results		
Nominal Voltage	V	
Vmin	V	
Vmax	V	
Specific Power	W/kg	
Current	A	
Specific Energy	Wh/kg	
Time	s	
Charge Energy	Wh	
Discharge Energy	Wh	
Specific Discharge Capacity	mAh/g	
Charge Capacity	Ah	
Discharge Capacity	Ah	
Irreversible Capacity	mAh/g	
Capacity Retention	%	
Energy Efficiency	%	
Coulombic Efficiency	%	
Analysis Notes		
Data Ownership		
Testing Organization	GRC/LEX	
Funding Organization	NASA ARMD	
Project Information		
Project Name	M-SHELLS	
Contract No.		

Figure C-2. “Test Information” Worksheet Format for Template-based Files (Pt 2 of 2).

Table C-1. Source Data Specifications for Data Displayed on Template-Based File's "Test Information" Worksheet, Part 1 of 2

Data Derivation Source*	Source Data Referenced	"Test Information" Data Label
Raw test data file name (excluding extension)	-	Record Name
"Pedigree Info" worksheet	Cell #	Short Name
Portion of raw test data file name that follows embedded source data value and precedes file name extension, with all "_" characters replaced with " " (blank)	Cell #	Test Description
Numeric portion of source value	Cell #	Experiment No.
Manually added by user	-	Testing Standard
"Global_Info_Data" worksheet	Creator	Test Operator
Manually added by user	-	Test Machine
Text to the left of first blank in "Global_Info_Data" worksheet source data value or, if no blank found, entire text string, if text format is consistent with a valid date format	Start Date/Time	Date Test Performed
Raw test data file name (including extension)	-	Original Data Filename
"Global_Info_Data" worksheet	Comments	Testing Notes
"Pedigree Info" worksheet	Cell #	Cell No.
Defaulted to "Coin" – May be modified using provided dropdown	-	Cell Type
Manually added by user	-	No. of Layers
Manually added by user	-	Cell Type (Other)
Software-determined, based on presence or absence of "Pedigree Info" worksheet source data values	Anode weight (mg) and Cathode weight (mg)	Structure
"Pedigree Info" worksheet	Anode diameter (in)	Anode Diameter
"Pedigree Info" worksheet	Cathode diameter (in)	Cathode Diameter
Manually added by user	-	Separator Diameter
"Pedigree Info" worksheet	Cell Thickness (in)	Cell Thickness
Manually added by user	-	Anode Thickness
Manually added by user	-	Cathode Thickness
Manually added by user	-	Separator Thickness
"Pedigree Info" worksheet	Cell weight (g)	Cell Weight
Manually added by user	-	Test System Notes
"Pedigree Info" worksheet	Anode Material	Anode Material
"Pedigree Info" worksheet	Anode Material #	Anode Material ID
"Pedigree Info" worksheet	Anode Active Material (%)	Anode % Active Material
Manually added by user	-	Anode Notes
"Pedigree Info" worksheet	Cathode Material	Cathode Material
"Pedigree Info" worksheet	Cathode Material #	Cathode Material ID
"Pedigree Info" worksheet	Cathode Active Material (%)	Cathode % Active Material
Manually added by user	-	Cathode Notes
"Pedigree Info" worksheet	Anode substrate material	Anode Substrate Material
"Pedigree Info" worksheet	Cathode substrate material	Cathode Substrate Material

\* Values listed as "Manually added by user" must either be provided by the user or they will remain blank.

Table C-2. Source Data Specifications for Data Displayed on Template-Based File's "Test Information" Worksheet, Part 2 of 2

Data Derivation Source*	Source Data Referenced	"Test Information" Data Label
Manually added by user	-	Separator Material
Manually added by user	-	Separator Material ID
Manually added by user	-	Electrolyte
Manually added by user	-	Electrolyte Type ID
"Pedigree Info" worksheet	Anode Active weight (mg)	Anode Active Weight
"Pedigree Info" worksheet	Anode coating weight (mg)	Coating
"Pedigree Info" worksheet	Normalized (by area) Anode Weight (mg)	Normalized
"Pedigree Info" worksheet	Cathode active weight (mg)	Cathode Active Weight
"Pedigree Info" worksheet	Cathode coating weight (mg)	Coating
"Pedigree Info" worksheet	Normalized (by area) Cathode Weight (mg)	Normalized
"Pedigree Info" worksheet	Total Active Weight (mg)	Total Active Weight
"Pedigree Info" worksheet	Anode substrate weight (mg)	Anode Substrate Weight
"Pedigree Info" worksheet	Cathode substrate weight (mg)	Cathode Substrate Weight
"Pedigree Info" worksheet	Cell Open Circuit Voltage (V)	Open Circuit Voltage
"Global_Info_Data" worksheet	Internal Resistance(Ohm)	Internal Resistance
Manually added by user	-	Impedance
Manually added by user	-	Test Temperature
Manually added by user	-	Voltage Window
Manually added by user	-	Test Condition Notes
Manually added by user	-	Nominal Voltage
Manually added by user	-	Vmin
Manually added by user	-	Vmax
Manually added by user	-	Specific Power
Manually added by user	-	Current
Manually added by user	-	Specific Energy
Manually added by user	-	Time
Manually added by user	-	Charge Energy
Manually added by user	-	Discharge Energy
Manually added by user	-	Specific Discharge Capacity
Manually added by user	-	Charge Capacity
Manually added by user	-	Discharge Capacity
Manually added by user	-	Irreversible Capacity
Manually added by user	-	Capacity Retention
Manually added by user	-	Energy Efficiency
Manually added by user	-	Coulombic Efficiency
Manually added by user	-	Analysis Notes
Defaulted to GRC/LEX - May be modified manually by user	-	Testing Organization
Defaulted to NASA ARMD - May be modified manually by user	-	Funding Organization
Defaulted to M-SHELLS - May be modified manually by user	-	Project Name
Manually added by user	-	Contract No.

\* Values listed as "Manually added by user" must either be provided by the user or they will remain blank.





